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The Sesamoid Articular

A Bone in the Mandible of Fishes

BY

EDWIN CHAPIN STARKS
Assistant Professor of Zoology

WITH FIFTEEN TEXT FIGURES

[Issued March 31, 1916]

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PRESS

THE SESAMOID ARTICULAR: A BONE IN THE MANDIBLE OF FISHES

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INTRODUCTION

The sesamoid articular is a small bone on the inner surface of the articular of fishes giving attachment to a stout tendon from the adductor mandibulae muscles.

This investigation was undertaken to ascertain in what groups of fishes it might occur; what its variation and condition might be in different groups; and to give the early history of the literature, which recent authors seem to be ignorant of.

Originally it was intended to work on the homologies of the adductor mandibulae muscles in order better to establish the identity of the sesamoid articular and its tendon; but after considerable work (done mostly at the Zoological Station at Naples in January and February of 1915), it appeared that the muscles are so variable in size, position, and relationship to each other that the sesamoid articular and its tendon were more valuable in identifying the muscle than the reverse.

A few of the drawings and brief descriptions of the muscles are here presented, and show their diversity of form and position. Many other fishes were worked on, but to report on all of them does not appear to be of advantage to the present inquiry.

The first notice of the sesamoid articular occurs in Cuvier and Valencienne's Histoire Naturelle des Poissons. Cuvier found it in the perch, and published such a picture of it that there can be no question as

to its identity. He called it the Operculaire (number 37 of his picture), homologizing it with a bone in the jaw of reptiles that he called by the same name, supposing the reptile bone homologous with the true opercle bone of fishes, though in the fish he also uses this name (number 28) for the bone commonly so called.

In 1846 Owen, in his Lectures on Comparative Anatomy and Physiology of the Vertebrates, published a picture of the mandible of the Sudis, *Arapiama gigas,* with the following remarks: "The great Sudis and the Polypterus have the splint-like plate along the inner surface of the ramus, answering to that which Camper and Cuvier have unfortunately called 'operculaire' in the mandible of reptiles, but to which I have given the name of 'splenial' to prevent the confusion from the synonymy with the true opercular bone of fishes." Later in his Comparative Anatomy Owen included *Amiatus* with the other two forms, and adds: the splenial "supports teeth and develops a coronoid process."

It thus appears that Owen's splenial is the bone that usually bears that name in the Ganoids. It need scarcely be added that no homology exists between the splenial, which is clearly a dental cement bone, and the sesamoid articular (Cuvier's operculaire).

Günther, in his Introduction to the Study of Fishes (p. 91), makes a similar mistake when he refers to the os operculare as a synonym of the splenial as follows. "The splenial or os operculare, which is situated on the inside of the articulary."

Ridewood (Linn. Soc. Jour., XXIX, p. 267), in writing of the mandible of the Sudis, says: "Although the bony lamina that bears the teeth occupies the position of the splenial bone, it is not a distinct plate of bone as might be concluded from the remark of Owen." There can be little question but that Owen referred to this inseparable toothed plate, rather than to a sesamoid articular. Dr. Ridewood reports the sesamoid articular not present.

Owen, in a table of synonyms that he published in his Lectures, includes the name subvomeral of Geoffroy St. Hilaire. I fail to find the term in the paper Owen cites (Ann. des. Sci. Nat., III, 1824), and therefore can not be sure whether it is the homolog of the sesamoid articular or of the splenial; but if of the former it is an earlier account of the bone than the one given by Cuvier.

Agassiz also uses the term operculaire for the splenial of *Polypterus* and *Lepisosteus* (Poissons Fossiles, vol. 2, part 2, pp. 20 and 42, pl. B and C, 1843), but in the Sudis (Piscium Brasiliensium, pl. B, 1829) he applies operculaire to an entirely different bone, that Owen in the same

form called the surangular—confusing it with the surangular of Ganoids —and that Ridewood says, is "merely the endosteal articular displaced."

Erdl, in his work on *Gymnarchus,* labeled the sesamoid articular, in both German and Latin, the kronenforsatz des Unterkiefers, pars coronoidea mandibulae. He thus, doubtless, as Cope did later, considered it the homolog of the coronoid of reptiles.

Bridge in 1877 described the bone in *Amiatus* that I have herein homologized as the sesamoid articular. He termed it simply ossicle C, but since that time every anatomist who has worked on *Amiatus* has referred to it as "ossicle C of Bridge."

The last author to write of this bone was Ridewood (Proc. Zool. Soc. Lond., 1904, p. 72), whom I follow in the use of the term 'sesamoid articular' as the best suggested for it. It is the Anglicized form of Vetter's Sesamoidverknöcherung. He gives a history of the literature of the bone since the time of Cope, which I need not here repeat. Among the papers touched upon he gives undeserved prominence to a hastily prepared foot-note published by me in 1899 (Proc. U. S. Nat. Mus., XXII), in which I listed various unrelated forms that possessed a sesamoid articular. My material was such prepared skeletons as happened to be at hand, and the note was published purely with the object of showing the worthlessness of the bone in taxonomy as used by Cope. As my discussion was based on Cope's paper I followed him in the use of the term 'coronoid bone' without thought of homology.

Most of the examples I reported upon were adult; and because the bone happened to be missing in a young individual of *Mugil,* the question was brought up as to whether it was not the ossified end of the tendon, that is always attached to it, developed with age. This seemed more probable at that time, as I was investigating the skeleton of *Dallia* in which the posttemporal ligament ossifies rather late in life. In the young *Mugil* referred to the bone was doubtless lost in preparing the skeleton, for I find it well developed in much smaller individuals that those reported upon.

It has seemed most convenient for the needs of this paper to follow no scheme of grouping. The captions are not at all coordinate in value, nor are they consistent in terminology. For instance, the small orders of Ganoids together with the lung fishes are under one caption. "The eels" includes two orders; "the clupeoid fishes" is of superfamily rank; and the spiny-rayed fishes are grouped under such comprehensive captions as "the blennies" or "the mailed-cheeked fishes," or even under family names.

Where the term 'endosteal' or 'ectosteal part of the articular' is used it does not mean that these elements are necessarily separate. Nearly always the anterior end of the endosteal part remains distinct from the ectosteal part, though no trace of suture may remain. The endosteal part forms the surface for the articulation of the quadrate, and usually projects forward in a process, which I have herein referred to as the endosteal process. The process abruptly becomes Meckel's cartilage (or more correctly Meckel's cartilage abruptly ossifies to form the endosteal process). Often the anterior part of the endosteal process is of the same size and shape as Meckel's cartilage, and the line of demarcation between the two is difficult to appreciate, by sight alone, until the latter begins to dry. The ectosteal part of the articular, usually herein called the ectosteal plate, lies outward from the endosteal part and forms the greater part of the bone. It is the continuation of the part articulating with the dentary, sheltering Meckel's cartilage on the outer surface.

I may here point out the danger of reporting on the absence of the sesamoid articular in material that the investigator has not prepared for himself, for it is often so loosely attached to the other elements of the mandible, and so firmly to the tendon, that in cleaning the bones it is easily removed with the latter. For instance, I found it in all of the Clupeoid forms that I examined, though in several of them it has been reported absent.

It was the original intention to investigate the development of the bone; but from lack of good material it appears better to publish the paper in its present form, reserving the development for the indefinite future when, it is hoped, material shall have accumulated to illustrate the various phases of it.

SYNONYMY

Operculaire Cuvier (C. & V. Hist. Nat. Pois., 1827).
Kronenforsatz des Unterkiefers, pars coronoidea mandibulae Erdl (Abhand. Bayer Akad. Wiss., V—I, 1847).
Ossicle C. Bridge (Jour. Anat. Phys., XI, part 4, 1877).
Sesamoidverknöcherung Vetter (Jena Zeitschr., XII, 1878).
Coronoid Cope (Proc. Am. Phil. Soc., XVII, 1878).
Addentary Gill (Proc. U. S. Nat. Mus., XVIII, 1895).
Sesamoid articular Ridewood (Proc. Zool. Soc. Lond., 1909).

THE ADDUCTOR MANDIBULAE MUSCLES

Scorpaena scrofa.

This short description and drawing is presented only to include a common type. Dr. Allis, in his Cranial Anatomy of the Mail-Cheeked Fishes (Zoologica Stuttgart, H, 57, 1909), has given a very complete, and much better description.

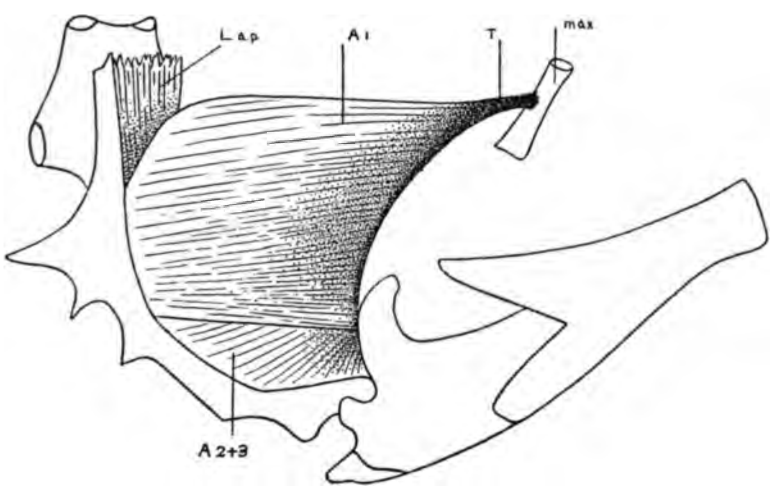

Fig. 1.—SCORPAENA SCROFA

A 1-2-3, muscles of Vetter; *Lap*, levator arcus palatini; *max*, maxillary; *T*, tendon.

The superior part of the adductor mandibulae consists of two parts: (1) A dorsal muscle originating on the preopercle and running forward to a broad tendinous band along its entire front, which at its upper end forms a tendon to the maxillary, and at its lower joins the tendons of the ventral muscle to the mandible. (2) A ventral muscle originating on the preopercle (and on other bones anterior to it), and covered on its upper part by the dorsal muscle. Anteriorly it is inserted on three tendons running to the mandible; the middle one of which is the sesamoid articular tendon. This muscle represents A-2+3 of Vetter.* According to

*Vetter. Janaische Zeitschr., XII, 1878.

Dr. Allis that part of it that posteriorly runs internal to the levator arcus palatini may represent A-3 and the part external to it A-2.

Dentex vulgaris.

The superior part of the adductor mandibulae muscle consists of two parts: (1) A dorsal muscle which at first sight appears to be made up of two muscles—an outer and an inner one. The outer part is strongly attached to the maxillary at one end by a short stout tendon, and to the preopercular ridge at the other end by a longer, but scarcely less stout, tendon. Above the preopercular tendon projects the inner part. It originates on the preopercle and runs downward and forward obliquely behind the outer part, and is attached anteriorly to the lower edge of the outer part, and to a thick sheet of tendon that covers the greater part

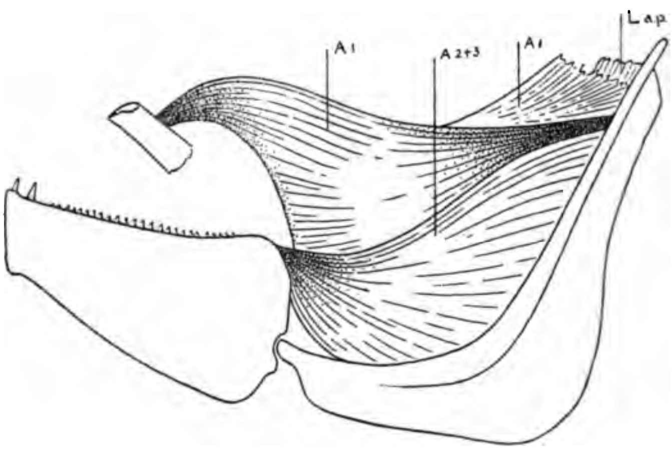

Fig. 2.—DENTEX VULGARIS
A 1-2-3, muscles of Vetter; *Lap*, levator arcus palatini.

of the inner surface of all of the muscles. The lower edges of the inner and the outer parts are continuous, so that when the two are spread out it is apparent that they are a single muscle folded upon itself. It represents A-1 of Vetter.

(2) A ventral muscle, which is larger than the dorsal muscle, originates on the preopercular ridge and the surface of the anterior adjoining bones. The thick sheet of tendon, that covers much of the inner part of this and the dorsal muscle, shallowly invades this muscle at about its middle, and along the plane of this invasion the muscle may be rather

easily separated. The inner part thus separated may represent A-3 of Vetter, and the outer part A-2.

The upper part of the sheet of tendon is free from the muscle and at its anterior end helps to form the maxillary tendon. Continuous with this sheet of tendon is the tendinous covering of the inferior part of the adductor mandibulae, or the part confined to the mandible (A-ω of Vetter), which posteriorly sends back a bundle of fibers to the middle of the quadrate. Dissecting this tendinous covering away a stout sesamoid articular tendon is found, which comes from the lower part of the sheet of tendon, or the part covering the ventral muscle (A-2+3). Attached to the articular below the sesamoid articular and below Meckel's cartilage is a less compact bundle of tendinous fibers from the same source. Crossing these two, and attached still lower on the articular, is another bundle of fibers coming more directly from the upper part of the sheet of tendon, or the part covering the dorsal muscle (A-1).

The levator arcus palatini muscle is very small, and no part of the adductor mandibulae runs behind it.

Tylosurus acus.

The superior portion of the adductor mandibulae is in two parts: (1) An external part that is ventral to the internal muscle, instead of dorsal to it as in *Scorpaena*. It originates on the preopercle and covers a considerable portion of the levator arcus palatini and of the internal

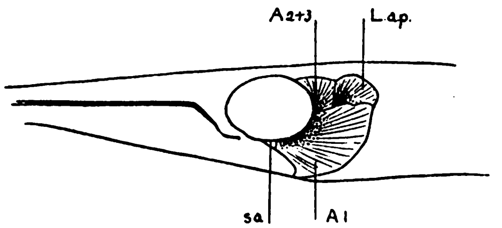

Fig. 3.—TYLOSURUS ACUS

A 1-2-3, muscles of Vetter; *Lap*, levator arcus palatini; *sa*, sesamoid articular.

muscle. Its tendinous surface fibers on its lower part converge and are joined directly to the sesamoid articular, while those of the upper part are attached to the tendon which descends from the dorsal internal muscle and borders its anterior edge. (2) The portion referred to above as the dorsal internal muscle has its origin on the anterior edge of the hyomandibular and the surface of the metapterygoid. Posteriorly

it is covered by the levator arcus palatini. It sends down a stout tendon bordering the posterior orbital margin, and the anterior edge of the ventral muscle as described, and joins the sesamoid articular. As neither of these muscles sends a tendon to the maxillary, and as each contributes to the sesamoid articular, the homologies of the two parts are not very clear. From their relation with the levator arcus palatini the outer ventral muscle would seem to represent A-1 of Vetter, and the dorsal inner muscle A-2 (+3?).

Mugil cephalus.

The superior part of the adductor mandibulae muscle consists of three parts: (1) A lower outer muscle which originates on the preopercular ridge and is connected by a stout tendon to the maxillary (A-1 of Vetter). (2) A muscle situated above and partly under the first originates higher on the preopercular ridge, and lies outside of the levator arcus palatini muscle (A-2 of Vetter). (3) The third is almost wholly

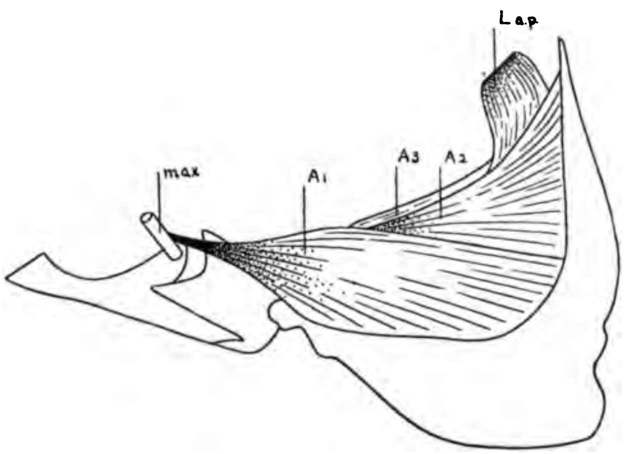

Fig. 4.—MUGIL CEPHALUS
A 1-2-3, muscles of Vetter; *Lap*, levator arcus palatini; *max*, maxillary.

covered by the second, its posterior end lying under the levator arcus palatini, and originating on the surface of the metapterygoid. The second and third unite anteriorly in a stout sesamoid articular tendon. The inferior, or mandibular part of the muscle (A-ω of Vetter), which is almost confined to the mandible, consists of two parts. The upper part gives off a broad band of tendon which connects it with the front of the quadrate, and it also sends a few fibers to join the sesamoid articular

tendon. The lower part is longer and inward from the first. It runs back to just in front of where the interhyal joins the face bones.

Leiognathus fasciatus.

This form is unique in having two equally stout tendons to the sesamoid articular. A large muscle (A-1 of Vetter) springs from the preopercle and covers the cheek. Its fibers converge to a point anteriorly from which a stout tendon runs upward and forward to the maxillary, and another downward and backward to the posterior end of the sesamoid articular. A long muscle (A-3 of Vetter) springing from under the levator arcus palatini gives rise to a second tendon, which, crossing the first tendon, reaches the sesamoid articular near its middle.

THE SESAMOID ARTICULAR

THE GANOIDS AND LUNG-FISHES.

Acipenser transmontanus, A. mikadoi.

In this genus I find only two bones: the very large dentary, forming the greater part of the mandible, and a small splint of bone lying on the inner surface of Meckel's cartilage. (In large specimens a mento-meckelian bone is developed in the anterior part of Meckel's cartilage and forms a third element.) From its position the small inner splint might either represent the sesamoid articular or the splenial. The tendon, however, of the adductor mandibulae (or at least the muscle that functions as such) is attached to the upper edge of the cartilage between this inner bone and the dentary, and though some outer fibers of the tendon are attached to the edges of both bones, the main attachment would suggest that no sesamoid articular were present and that the inner bone represents the splenial. It is the bone called the coronoid by W. K. Parker in his Structure and Development of the Skull in Sturgeons (Phil. Trans., 1882, p. 173, pl. 18). In my specimens it is much larger than is shown in Dr. Parker's plate, and is everywhere isolated from the dentary by cartilage.

Lepisosteus platostomus, L. osseus.

Among the eight elements that make up the mandible of *Lepisosteus* (two of which are presplenials) I find none that I can homologize with the sesamoid articular, unless it be an inner shelf of the splenial in the coronoid region. This is not in the typical region for the sesamoid articular, being remote from Meckel's cartilage, and the only ground for considering the possibility of this homology is that a stout adductor tendon is attached to it. A tendinous band also gives muscle attachment to the edge of the supra-angular. I have examined several specimens of various sizes down to 3½ inches in length, but find no indication of this inner splenial process as a separate element.

Amiatus calva.

Just above the posterior part of Meckel's cartilage are two small bones in the typical position of the sesamoid articular. They were first noticed by Bridge (Jour. Anat. Phys., vol. XI, 1877), who designated them on his drawing of the mandible of *Amiatus* as *"c"* and *"b"* and so referred to them without giving them names. To ossicle *c* is attached a tendon from muscles that are probably homologous with parts of the adductor mandibulae muscles in more highly specialized teleosts.* Dr. Ridewood (Proc. Zool. Soc. Lond., 1904, p. 56) has failed to find these two ossicles as separate bones and has homologized them with the endo-articular. In two adult specimens I have at hand, however, these two bones are very evident. Ossicle *c* is the sesamoid articular, and ossicle *b* only represents the endoarticular.

Polypterus bichir.

In *Polypterus* I find no separate sesamoid articular, but on the inner surface of the articular, just above Meckel's cartilage, in the typical place for the sesamoid articular is a projecting shelf of bone to which a stout adductor tendon is strongly attached. My only specimen is one 18 inches in length. In the young I should confidently expect to find this process as a separate sesamoid articular.

Ceratodus forsteri.

Of the lung-fishes I have only *Ceratodus* in which I find no sesamoid articular. A big bundle of tendons gives muscle attachment to both the ectoarticular and splenial just behind the mandibular tooth in the coronoid region. In the other lung-fishes there is no bone in published descriptions or figures that could be homologized with the sesamoid articular.

THE CLUPEOID FISHES.

Dr. Ridewood, "On the Cranial Osteology of the Fishes of the Families Elopidae and Albulidae" (Proc. Zool. Soc. Lond., 1904), reports the sesamoid articular present in *Elops saurus* and in *Albula vulpes,* not present in *Pterothrissus gissu* (*Bathythrissa dorsalis*), and in *Megalops cyprinoides* he does not mention it, but he states that except for proportions it resembles *Elops.*

*For a discussion of these see Allis, Cranial Muscles and Nerves of Amia calva. (Jour. Morph., XII, 1897, pp. 554, 580 and 752.)

In his paper "On the Cranial Osteology of the Fishes of the Families Mormyridae, Notopteridae, and Hyodontidae" (Jour. Linn. Soc., vol. XXIX), he reports a sesamoid articular present in *Notopterus kapirat* and *Hiodon alosoides*.

In his paper "On the Cranial Osteology of the Clupeoid Fishes" (Proc. Zool. Soc. Lond., 1904) he finds a sesamoid present in *Chirocentrus dorab, Alosa finta,* and *Chanos chanos,* but fails to find any in *Clupea harengus, Dussumieria acuta, Engraulus encrasicholus,* or *Coilia nasus.* In *Dorosoma erebi* he mentions neither its presence nor absence.

In his paper "On the Cranial Osteology of the Fishes of the Families Osteoglossidae, Pantodontidae, and Phractolaemidae" (Jour. Linn. Soc., vol. XXIX) he reports a sesamoid articular present in *Osteoglossum leichardti,* and *Heterotis niloticus,* but absent in *Arapaima gigas.* In *Pantodon buchholzi,* and in *Phractolaemus ansorgii,* he does not mention a sesamoid articular, but his material was in the form of prepared skulls and its absence might only mean that it was lost in preparing.

In his paper "On the Skull of Gonorhynchus greyi" (Ann. Mag. Nat. Hist., 1905) he reports a sesamoid articular present in *Gonorhynchus greyi.*

Elops saurus.

The rather small sesamoid articular is attached to the ectosteal part of the articular far in front of the endosteal part, and is somewhat covered with Meckel's cartilage. A deep cavity, open in front, is partitioned off in the ectosteal part just behind the sesamoid articular by a thin plate of bone. This is shown in Dr. Ridewood's picture (Proc. Zool. Soc. Lond., 1904, vol. II, p. 40).

Albula vulpes.

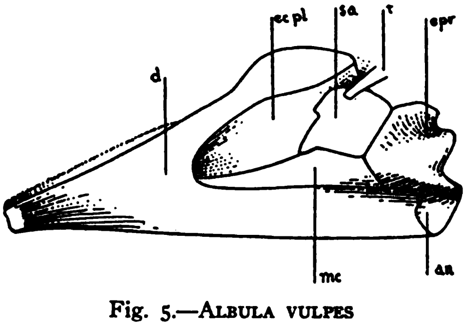

Fig. 5.—Albula vulpes

an, angular; *d,* dentary; *ecpl,* ectosteal plate; *epr,* endosteal process; *mc,* Meckel's cartilage; *sa,* sesamoid articular; *t,* tendon.

The sesamoid articular is a very large, thick bone closely attached to the front of the endosteal part of the articular, with its outer surface against the ectosteal part. Its surface is almost as great as that of the endosteal part, and has the appearance of being in as close relationship with Meckel's cartilage. Its structure, its union with Meckel's cartilage, and its concave lower edge, from which the cartilage issues, are all strikingly like the endosteal part.

Dorosoma cepedianum.

Dr. Ridewood reported on *Dorosoma erebi,* and did not mention a sesamoid articular or show one in his picture. This species has a well developed one in front of the cup-shaped process of the endosteal part of the articular, and partly covered by Meckel's cartilage.

Dussumieria elopsoides.

Dr. Ridewood reports the sesamoid missing in *Dussumieria acuta,* but in this species there is a small one situated against the articular and partly covered by Meckel's cartilage.

Clupea pallasii.

Dr. Ridewood reports the sesamoid articular missing in *Clupea harangulus.* In this closely related species it is present, situated against the articular just in front of the endosteal process, and covered by the base of Meckel's cartilage.

Opisthonema oglinum.

The sesamoid articular is moderately large, and is situated on the upper part of Meckel's cartilage and the endosteal process.

Coilia nasus.

In this form Dr. Ridewood failed to find a sesamoid articular. A small one is present, however, in the deep notch that is formed directly in front of the articulating surface of the quadrate, and covered by Meckel's cartilage. The line of demarcation between the endosteal and ectosteal parts of the articular is not evident.

Pterengraulis atherinoides.

Though much larger and of more dense bone, the sesamoid articular is essentially as in *Coilia nasus.*

Engraulis encrasicholus.

In this species the sesamoid articular is large and essentially as in *Pterengraulis* and *Coilia,* being as large as in the former. Dr. Ridewood reports it missing, it having doubtless been lost in preparing the specimen, for it is easily pulled away and remains attached to its tendon.

Pterothrissus gissu (Bathythrissa dorsalis).

Dr. Ridewood reports the sesamoid articular unossified in this form. It is, however, very well developed, and is placed saddle-like over Meckel's cartilage remote from the endosteal process. It, like *Engraulis,* has this bone so loosely attached that it is liable to be removed with its tendon.

THE SALMONOID FISHES.

Salmo irideus.

A small sesamoid articular is loosely attached against the ectosteal part of the articular remote from the endosteal part, and is partly covered by the slender Meckel's cartilage.

Osmerus dentex.

In this the sesamoid articular is essentially as in *Salmo.*

Thymallus signifer.

The sesamoid articular is moderately large, and on the upper edge of Meckel's cartilage remote from the endosteal part of the articular.

Argyrosomus hoyi.

In this form the sesamoid articular is rather large, situated on the upper surface of Meckel's cartilage, and in contact with both the endosteal and ectosteal parts of the articular.

THE SYNODONTIDÆ.

Synodus lucioceps.

In this the sesamoid articular is large. It is attached to the endosteal part of the articular at the inner side and posterior end, and arches over Meckel's cartilage to the ectosteal part of the articular.

THE EELS.

In all the examples examined the dentary forms a sheath about the articular, hiding Meckel's cartilage completely from view, and covering the anterior part of the sesamoid articular. The sesamoid articular tendon is well developed.

Symbranchus marmoratus.

A moderately large sesamoid articular is situated on the articular above the endosteal process and base of Meckel's cartilage. The tendon from the sesamoid articular is a flat band somewhat connected with a similar band attached more posteriorly on the articular. A great mass of tendinous tissue gives muscle attachment to the upper, posterior process of the dentary.

Anguilla chrysypa.

The sesamoid articular is situated on the endosteal process of the articular, and is covered anteriorly by the inner plate of the dentary, under which it extends forward over Meckel's cartilage.

Synaphobranchus pinnatus.

The sesamoid articular is an exceedingly slender splint of bone covering Meckel's cartilage on its upper and inner surface, directly in front of where the cartilage issues from the endosteal process of the articular, and extending forward into the dentary sheath.

Leptocephalus conger.

In this form the articular is anteriorly divided. The lower division is entirely outside of the dentary, running along its outer lower edge, while the upper division is sheathed by the dentary. A very large sesamoid articular is on the endosteal part of the upper fork and forms with it the cavity from which Meckel's cartilage issues, and which is usually confined to the endosteal process, though here the sesamoid articular forms the greater part of it. The sheath of the dentary fits tightly about the articular and the sesamoid articular, leaving only a minute hole into the dentary sheath above the sesamoid articular.

Muraenesox coniceps.

The sesamoid articular is on the endosteal process of the articular,

and extends into the cavity of the dentary sheath along the top of Meckel's cartilage. The dentary sheath is wide open behind, unlike that of *Leptocephalus conger*.

Ophichthus triserialis, Ophisurus serpens, Lycodontis castaneus.

In these forms the sesamoid articular and its relationship to the surrounding elements differ in no important way from that of *Muraenesox*.

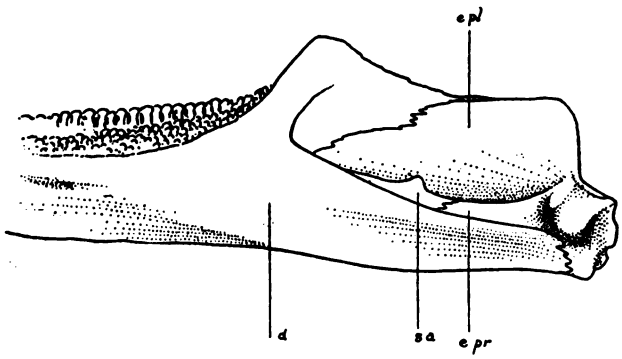

Fig. 6.—LYCODONTIS CASTANEUS
d, dentary; *epl*, ectosteal plate; *epr*, endosteal process; *sa*, sesamoid articular.

THE HETEROGNATHOUS FISHES.

Hoplias microlepis.

The sesamoid articular is a thick, irregular bone on top of Meckel's cartilage, and attached against the articular just anterior to the endosteal process of that bone. The tendon is slender.

Curimatus isognathus.

In this the sesamoid articular is placed as in *Hoplias*, but the bone is thinner and flatter and fits more broadly on the articular.

Hydrocynus cuvieri.

The sesamoid is a flat bone with a tubercle for the attachment of the tendon. It lies closely against the ectosteal part of the articular on top of Meckel's cartilage and the endosteal process.

THE EVENTOGNATHOUS FISHES.

Deltistes luxatus, here described, but **Ictiobus bubalus, Chasmistes brevirostris, Myxostoma aureolum** differ only as noted.

Meckel's cartilage appears as a short, deep, thin, somewhat quadrangular plate, situated rather high on the mandible. Posteriorly it abruptly ends against the endosteal process of the articular. Anteriorly it ends in a similar way against a portion of the dentary, which may represent the mento-meckelian ossicle of some of the Ganoids here incorporated with the rest of the dentary.

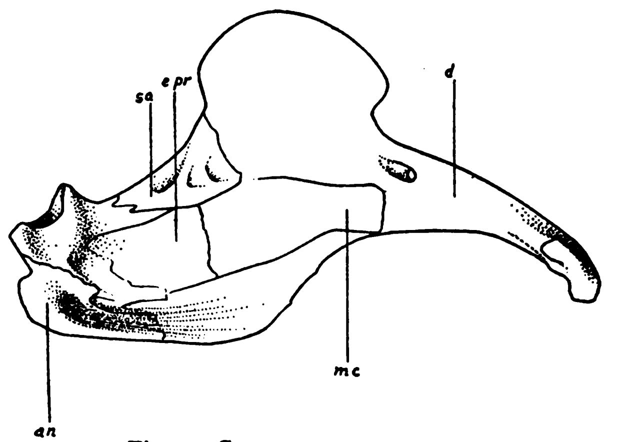

Fig. 7.—Chasmistes brevirostris

an, angular; *d*, dentary; *epr*, endosteal process; *mc*, Meckel's cartilage; *sa*, sesamoid articular.

The sesamoid articular is a very large flat plate, somewhat triangular in shape, its upper edge nearly even with the upper edge of the mandible, and its lower about equally overlying Meckel's cartilage and the endosteal process of the articular. It lies broadly, and is connected rather firmly, against the articular, and its anterior end overlaps the dentary. This is unique to my knowledge, for in other forms it is confined to the articular, though in the eels the dentary overlies it. In *Chasmistes* the condition is the same, but in the other two forms the sesamoid articular does not reach to the dentary. Considerable variation was found in this character (all specimens were of rather large size), and as it is of secondary development it is of little importance. The tendon is large and flat, and is attached to the middle of the upper edge of the sesamoid articular.

Cyprinus carpio, Leuciscus bicolor, Semotilus atromaculatus, Ptychocheilus oregonensis, Orthodon microlepidotus, Pogonichthys macrolepidotus.

The sesamoid articular is more slender than in *Deltistes* et. al., more closely associated with Meckel's cartilage, which is much more slender, and it is lower in position, being remote from the upper margin of the

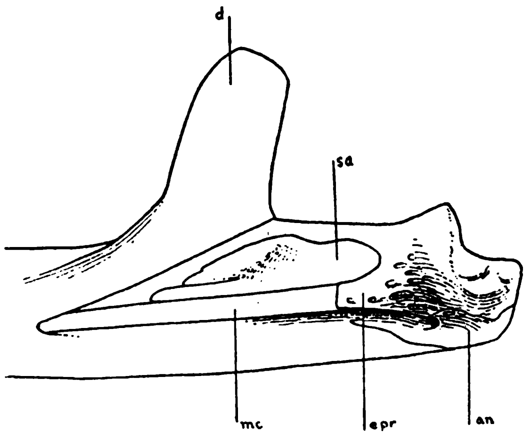

Fig. 8.—Leuciscus bicolor

an, angular; *d*, dentary; *epr*, endosteal process; *mc*, Meckel's cartilage; *sa*, sesamoid articular.

articular. It is a large flat bone lying closely against the articular, and articulated along its lower edge with the endosteal process and with Meckel's cartilage, being concave to fit over them. There is a prominent tubercle of bone above its middle to which a stout tendon is attached.

Misgurnus anguillicaudus.

In this form I fail to find a separate sesamoid articular, though a tendon is attached to the middle of the articular about in the typical place for one. The inner part of the articular is broken up into a lace-like plate which seems to be an integral part of it.

THE SILUROIDS.

Silurus glanis.

The sesamoid articular is smaller than in the other siluroids examined. It is situated on the upper inner edge of Meckel's cartilage, and a small

process from it joins the inner surface of the ectosteal plate of the articular, but does not articulate with the endosteal process. The tendon is large.

Amiurus catus.

A very large sesamoid articular is present. It is fitted saddle-like around the upper part of Meckel's cartilage. Its inner edge is articulated by a dentate suture with the inner edge of the endosteal process of the articular which covers the posterior part of Meckel's cartilage. Its outer surface lies flat against the inner surface of the ectosteal plate. It thus forms the roof of a cavity for Meckel's cartilage, the inner side wall of which is formed by the endosteal part of the articular.

Platystomatichthys sturio.

The sesamoid articular overlies the upper edge of Meckel's cartilage, and is articulated with the endosteal process but does not extend to the ectosteal plate of the articular. The tendon is attached to the extreme posterior upper corner of it.

Brachyplatystoma vaillanti.

Meckel's cartilage turns upward to the point of the coronoid process. A large sesamoid articular overlies the cartilage at a point where it turns up from the typical horizontal portion. It is articulated with the endosteal process of the articular, and arching over the cartilage attaches itself to the inner face of the ectosteal plate. Posteriorly, a little above its middle, is a blunt tubercle of bone to which the tendon is attached.

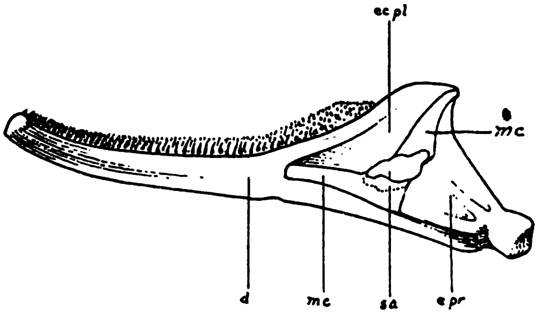

Fig. 9.—BRACHYPLATYSTOMA VAILLANTI

d, dentary; *ecpl*, ectosteal plate; *epr*, endosteal process; *mc*, Meckel's cartilage; *sa*, sesamoid articular.

Trachycorystes galeatus.

The sesamoid articular extends over the top of Meckel's cartilage, connecting the endosteal process and the ectosteal plate. The tendon is very large and stout.

Ictalurus furcatus.

In this the sesamoid articular is as in Brachyplatystoma, but much smaller and more slender.

Selenaspis dowii, Sciadeichthys troscheli.

In these the sesamoid articular is essentially as in *Amiurus*.

THE GYMNOTID FISHES.

Electrophorus electricus.

The sesamoid is here long and rod-like, and is situated against the ectosteal part of the articular in front of the endosteal part. It lies on and slightly arches over Meckel's cartilage. A large tubercle on its posterior end gives attachment to a very stout tendon.

Gymnotus carapo.

The sesamoid articular is a very large flat bone situated above the base of Meckel's cartilage and the endosteal process. It projects broadly over the inner surface of the latter and is strongly articulated to it. To a prominent tubercle on its posterior end a large tendon is attached.

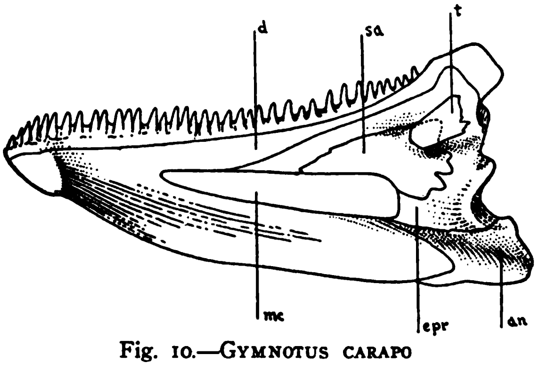

Fig. 10.—Gymnotus carapo

an, angular; *d*, dentary; *epr*, endosteal process; *mc*, Meckel's cartilage; *sa*, sesamoid articular; *t*, tendon.

THE SCYPHOPHORI.

Gymnarchus niloticus.

Dr. Ridewood presents a good plate of the mandible of this form (Linn. Soc. Jour., XXIX, pl. 23) in which the sesamoid articular is shown to be nearly as large as the endosteal articular, with which it is connected by a deeply dentate suture. It lies against the ectosteal part of the articular.

In the above paper a sesamoid articular is reported to be present in *Mormyrops deliciosus,* but not present in *Pterocephalus bane.*

THE HAPLOMI AND XENOMI.

Umbra lima, Dallia pectoralis.

These two are similar in having the sesamoid articular very large, attached far forward on the ectosteal plate with which it is broadly connected, concave on its lower surface to fit over Meckel's cartilage, and far remote from the endosteal part of the articular, which is little larger than is necessary to form the condyle for the quadrate.

Esox reticulatus.

The sesamoid articular is much smaller than in *Umbra,* and not placed so far forward on the ectosteal plate of the articular, nor so broadly connected. Otherwise it and the condition of the small endosteal part of the articular are similar.

Fundulus similis.

The large sesamoid articular lies about equally over the top of the endosteal process and Meckel's cartilage, with its outer surface against the ectosteal plate. The endosteal part of the articular, unlike that of *Esox,* is ossified well forward.

THE SYNENTOGNATHI

Tylosurus marinus, T. acus.

The sesamoid articular is an exceedingly large, flat bone, suturally attached to the ectosteal plate of the articular, and at its lower edge to

the endosteal process, extending forward over the posterior end of Meckel's cartilage. Upward and backward it projects above the articular in a process that shows to a considerable extent when viewing the mandible from the outer surface. To it the muscle is closely attached by tendinous tissue, as herein described under adductor muscles. It is of such a size and position that it is little wonder Cope called it the coronoid, though it is considerably behind the coronoid bone of reptiles, or the coronoid cartilage of *Amiatus*. The anterior upper angle of the articular of *Tylosurus*, which is just behind the dentary, is in the coronoid region.

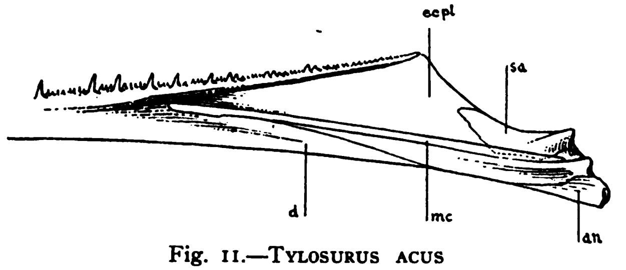

Fig. 11.—Tylosurus acus

an, angular; *d*, dentary; *ecpl*, ectosteal plate; *mc*, Meckel's cartilage; *sa*, sesamoid articular.

Exocœtus californicus.

The sesamoid articular is here as it is in *Tylosurus*, except that it scarcely extends above the articular to be visible from the outside.

Chirodorus atherinoides, Hemiramphus richardi.

These forms have the sesamoid articular essentially alike and almost identical with that of *Tylosurus*.

THE HEMIBRANCHIATE FISHES.

Gasterosteus cataphractus.

In this form the sesamoid articular is a nodule of bone on the upper part of Meckel's cartilage attached against the ectosteal plate of the articular far from the coronoid region, or the upper margin of the mandible. It is smaller than in the other Hemibranchiate fishes.

Macrorhamphosus sagifue.

At the upper edge of the broad Meckel's cartilage is a rather wide, disk-like sesamoid articular placed flat against the ectosteal plate, considerably above the endosteal part of the articular, and directly below the ascending process of the dentary. It extends upwards more than usual, thus approaching the condition of the Synentognathous fishes.

Fistularia petimba.

The dentary and articular are very complex in shape. Each of them has three forks, which more or less interlock. The middle fork of the dentary (by far the largest) fits between the middle and lower forks of the articular in a deep notch that extends back nearly to the condyle of the quadrate, thus almost dividing the articular into two parts. Directly above this division in the articular are the endosteal process of the articular and Meckel's cartilage. The upper forks of both elements arch upward, leaving an open space, above which they nearly meet. It is to the posterior edge of this upper fork of the articular, to a small process of bone, that the adductor tendon is attached. The process is remote from Meckel's cartilage, and is probably not the homolog of the sesamoid articular. In the smallest specimen available (5 inches long) no suture was apparent to indicate a separate element in this region.

Aulostoma valentini.

The elements of the mandible differ from those of *Fistularia* only in unimportant details. The upper fork of the dentary is scarcely developed, and that of the articular does not arch over an open space, but the posterior part of it bears a process (larger than in *Fistularia*) to which the adductor tendon is attached.

Aulorhynchus flavidus, Aulichthys japonicus.

The sesamoid articular is a very large plate, lying flat against the ectosteal part of the articular, and extending up from Meckel's cartilage, which it only barely touches, towards the coronoid region. To its upper end is attached a strong tendon, and to the coronoid process is attached a smaller, more fibrous one.

THE SALMOPERCÆ.

Percopsis guttatus.

The sesamoid articular is very loosely attached to the upper surface of Meckel's cartilage, slightly in contact with the endosteal process of the articular, but scarcely with the ectosteal part.

Aphredoderus sayanus.

The sesamoid articular is situated against the ectosteal plate of the articular, above and outward from the endosteal process, and nearly covered from sight by Meckel's cartilage.

THE PERCESOCES.

Atherinopsis californiensis

In this the sesamoid articular is very long. In a mandible 22 mm. in length it is one-third of this length. It is closely attached to the ectosteal plate of the articular, and still more closely to the top of the endosteal process. It overlies the top of Meckel's cartilage, and projects to a considerable extent between it and the articular. The adductor tendon attached to it is large.

Menidia notata.

The sesamoid articular is short and deep, attached to the upper and inner surface of Meckel's cartilage and the endosteal process of the articular, and to the ectosteal plate above them.

Sphyræna argentea.

The sesamoid articular is a small sliver of bone attached to the ectosteal plate of the articular in front of the endosteal process. It is nearly covered by Meckel's cartilage.

Mugil cephalus.

The sesamoid articular is here a rather large, thick disk of bone attached to the ectosteal plate and to the top of the endosteal process of the articular. It extends considerably above Meckel's cartilage, and is covered but slightly by it.

THE RHEGNOPTERI.

Polydactylus approximans.

In this form the endosteal process stands away from the ectosteal plate (inward from it), and a flat bridge of bone projects upward from it to near the edge of the ectosteal plate just in front of the condyle for the quadrate. The cavity behind it (outward from it) is doubtless the homolog of the chamber in the mandible of *Elops* in the same region, where it is completely separated as a chamber rather than simply bridged across. As the partition in Elops unquestionably belongs to the ectosteal part of the articular, it probably does here, though it is so completely anchylosed with the endosteal process that its boundary is obscure. The sesamoid articular is situated in the space between the endosteal process and the ectosteal plate. Its middle is opposite the end of the process, and it is equally in contact with the process and Meckel's cartilage, which entirely hide it as the mandible is viewed from the side.

THE BERYCOID FISHES.

Beryx splendens, Hoplostethus japonicus, Monocentris japonicus, Polymixia japonica.

In these forms the sesamoid articular is against the ectosteal plate on the outer side, and the endosteal process and Meckel's cartilage on the inner. Viewed from the side, the process and cartilage hide it from view. In *Hoplostethus* it is rather flat and disk-like. In *Beryx* it is a thick, elongate splint of bone with a tubercle at its middle for the attachment of the tendon. In *Polymixia* and *Monocentris* it is very small but thick. In *Monocentris* it is very loosely attached.

Holocentrus ascencionis, Myripristis occidentalis.

These two forms are similar in the condition of the sesamoid articular. It is of moderate size, situated against the ectosteal plate just in front of the endosteal process, and on its lower edge folding over the top of Meckel's cartilage.

THE SCOMBRIDÆ.

Scomber japonicus, Scomberomorus sierra, Sarda chilensis, Gymnosarda palamis, Acanthocybium solandri.

In all of these the sesamoid articular is rather small, situated on

Meckel's cartilage and against the ectosteal plate of the articular. In *Scomber* it is on the upper surface of the cartilage. In *Scomberomorus* it is somewhat between the cartilage and the articular. In *Sarda, Gymnosarda* and *Acanthocybium* it likewise is between but more above the cartilage. In all but *Acanthocybium* it is in contact with the end of the endosteal process, but in none of them is it on the upper surface of the process.

THE CARANGIDÆ.

Selene œrstedii, Naucrates ductor, Lichia glauca, Alectis ciliaris, Citula dorsalis, Chloroscombrus chrysurus, Caranx pisquetus, Megalaspis cordyla.

The sesamoid articular is covered more or less completely by the endosteal process and Meckel's cartilage as viewed from the side, lying with its outer surface against the ectosteal plate.

Trachurops crumenopthalmus, Nematistius pectoralis, Elegatis bipinnulatus, Decapterus punctatus, Trachurus mediterraneus.

The sesamoid articular is as in *Selene* et. al. but more anteriorly placed, and very slightly if at all in contact with the endosteal process. In *Trachurus* it is thinner and more broadly connected with the ectosteal plate than in the others.

Vomer setipinnis, Scomberoides toloparah, Gnathanodon speciosus.

In these the sesamoid articular is more on top of the endosteal process and Meckel's cartilage than behind them. In *Vomer* it is much less broadly connected with the ectosteal plate than in the other two.

OTHER SCOMBROID FISHES.

Leiognathus fasciatus.

The lower part of the articular is folded inward as well as abruptly thickened, thus forming a wide longitudinal shelf. The endosteal process is obscure. The sesamoid articular is a wide, thin plate (5 mm. long in a mandible 27 mm. long), closely attached horizontally to the longitudinal shelf. Meckel's cartilage is a very thin rod which disappears under the sesamoid articular. To the upper, flat surface of the sesamoid articular two equally stout tendons are attached: one a little behind its middle,

and one to its posterior end. Opposite the base of each tendon there is a rather deep depression in the articular, which show on the outer surface of the mandible as very thin spots where the bone is easily broken through. I have found no other example where two tendons join the sesamoid articular. The relationship of the tendons is herein described in the section devoted to adductor muscles.

Promethichthys prometheus, Lepidopus caudatus, Trichiurus lepturus.

The sesamoid articular is similar to that in the fishes of the family Scombridæ, rather small, more or less between the ectosteal plate and Meckel's cartilage, and just at the anterior end of the endosteal plate, with which it is in contact except in *Lepidopus*.

Pomatomus saltatrix, Palometa triacanthus, Peprilus paru.

The sesamoid articular is on the upper surface of Meckel's cartilage and the endosteal process, and on its outer surface it is against the ectosteal plate. In *Rachycentron* it is rather large and only slightly in contact with the endosteal process.

THE PERCOID FISHES.

Lobotes pacificus, Pomoxys sparoides, Priacanthus catalufa, Apogon maculatus, Sciaena stellifera, Nebris occidentalis, Mentacirrhus alburus, Polycirrhus dumerili.

In these the sesamoid articular is moderate in size or small, and is situated against the ectosteal plate with the endosteal process and Meckel's cartilage overlying it and hiding it from view more or less as it is viewed from the side.

Dentex vulgaris, Sargus rondeletii, Archosargus probatocephalus, Pagrus vulgaris, Diplodus argyrops, Pagrellus erythrynus, Lutianus aya, Girella nigricans, Oblata melanura.

The sesamoid articular is very much as in *Lobotes* et. al., but is on top of the endosteal process and Meckel's cartilage, and very little, if at all, hidden behind them. In *Archosargus* and *Pagrus* it is much more over the endosteal process than over Meckel's cartilage. In *Diplodus* this condition is reversed. In the others it is about equally over both.

Micropterus salmoides, Labrax lupus, Serranus atrarius, Roccus lineatus, Cynoscion maculatus.

In these the sesamoid articular is as in *Lobotes* et. al., but more anterior in position and not in contact with the endosteal process.

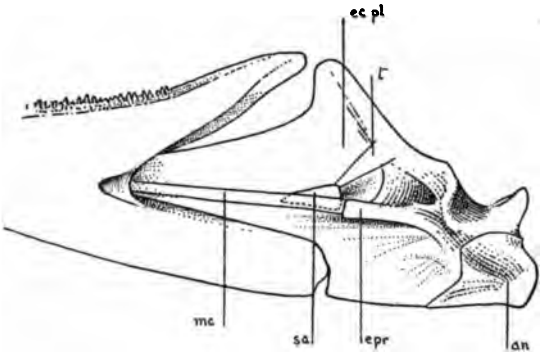

Fig. 12.—Labrax lupus
an, angular; *ecpl*, ectosteal plate; *epr*, endosteal process; *mc*, Meckel's cartilage; *sa*, sesamoid articular; *t*, tendon.

Orthopristis chrysopterus.

In this the sesamoid articular is very large. It is closely attached to the ectosteal plate, with about a sixth of its length resting on the endosteal process and the rest on Meckel's cartilage. It is long and tapers to a point anteriorly, while on the top of its posterior part is a very large tubercle of bone for the attachment of the adductor tendon.

THE PHARYNGOGNATHI.

Tautoga onitis, Crenilabrus pavo.

The sesamoid articular is on top of Meckel's cartilage, attached against the ectosteal plate and slightly attached to the endosteal process.

Harpe rufa.

There are two adductor tendons originating on the same muscle that are similar in size and structure as in *Leiognathus,* but only the upper one joins the sesamoid articular. The other is attached to the articular ventral to the endosteal process. When stripped of their muscle

they appear at the upper end as a single flat band, but they are easily separated. The sesamoid articular is as in *Tautoga,* though more broadly attached to the endosteal process.

Sparisoma flavescens.

The sesamoid articular is rather flat and disk-like. It is firmly attached against the ectosteal plate and the upper side of the endosteal process and Meckel's cartilage.

THE SQUAMIPINNES.

Chaetodipterus faber, Chaetodon bimaculatus, Holocanthus tricolor, Platax teira.

The sesamoid articular is closely attached against the ectosteal plate and about half hidden by the overlying endosteal process. In *Chaetodipterus* it is only slightly in contact with Meckel's cartilage; in the others it is broadly in contact. In *Chaetodon* it is more above the process and cartilage.

Drepane punctata.

In this the endosteal process is obscure. The sesamoid articular is small and disk-like, and is closely attached against the ectosteal plate, where it is hidden behind Meckel's cartilage.

Zanclus canescens.

The sesamoid articular is attached against the ectosteal plate only very slightly in contact with Meckel's cartilage and remote from the endosteal process.

Teuthis bahamus.

The articular is very short and its endosteal process reaches to its anterior end, leaving but little space for Meckel's cartilage. Almost directly at the anterior end of the articular, on the upper surface of the endosteal process and the base of Meckel's cartilage, is a rather large sesamoid articular.

Xesurus punctatus.

In this the endosteal process does not occupy so great a part of the articular as in *Teuthis,* and the sesamoid articular is confined to the upper surface of Meckel's cartilage and the endosteal part of the articular.

THE AMPHACANTHI.

Siganus fuscescens

The sesamoid articular is broad and flat; its flat side is firmly attached against the ectosteal plate, and its lower edge rests on the endosteal process and Meckel's cartilage. The tendon is attached near its center.

THE PLECTOGNATHI.

Balistes vetula.

The sesamoid articular is a thick nodule of bone on the upper surface of the endosteal process (whose limits are obscure) and Meckel's cartilage.

Spheroides annulatus.

In this form the sesamoid articular more evidently originates within the tendon than in any other example I have encountered. Near the mandible end of the tendon an area of it is ossified, forming a shaft of bone about four times as long as broad. The tendon is attached to the region of the endosteal process, which is obscure, at some distance behind Meckel's cartilage. Between the mandible and the ossified portion of the tendon (sesamoid articular) is a considerable area of unossified tendon. A large part of the inner surface of the dentary as well as the upper angle (coronoid region) of the articular and dentary, is covered by a great mass of tendon from the adductor muscles. The tendon that forms the sesamoid articular ossification is below this mass of tendon and comparatively small.

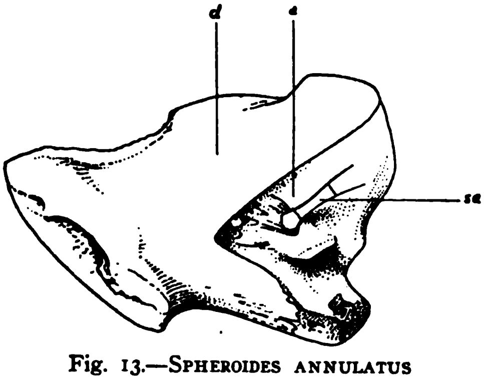

Fig. 13.—Spheroides annulatus
a, articular; *d*, dentary; *sa*, sesamoid articular.

Ovoides setosus.

This differs from *Spheroides* only in having the sesamoid articular attached more directly to the mandible without the intervention of much tendinous tissue, and in the bone being enlarged and spreading out at the end of the tendon.

Chilomycterus schoepfi.

The endosteal process is obscure. The sesamoid articular is rather large, and is attached closely against the articular just above Meckel's cartilage, which covers its lower edge.

Lactophrys tricornis.

The sesamoid articular is situated on the surface of the endosteal process, and on Meckel's cartilage to a very small extent.

THE MAIL-CHEEKED FISHES.

Scorpaena senorae, Scorpaena scrofa, Scorpaena ustulata, Scorpaena plumieri, Sebastes marinus, Sebastolobus alaskanus, Sebastodes flavidus, Prionotus evolans, Prionotus horrens, Trigla corax.

The sesamoid articular is situated against the ectosteal plate just in front of the endosteal process, and more or less completely hidden by Meckel's cartilage. In *Scorpaena scrofa* it is rather large and runs forward in a splint of bone. In *Trigla* it is moderate in size, and in the others it is small.

Zaniolepis latipinnis, Ophiodon elongatus, Liparis agassizii.

These differ from *Scorpaena* et. al. in having the sesamoid articular covered by the endosteal process as well as by Meckel's cartilage. In *Liparis* it is only slightly behind the process.

Hexagrammos decagrammus, Scorpaenichthys marmoratus, Myoxocephalus octodecemspinosus, Podothecus acipenserinus.

The sesamoid articular is more on top of the endosteal process and Meckel's cartilage than covered by them. It is closely connected with the ectosteal plate.

Hemilepidotus jordani.

The sesamoid articular is on top of Meckel's cartilage against the ectosteal plate and remote from the endosteal process.

THE GOBIES.

Dormitator latifrons.

The sesamoid articular is large and disk-shaped, with its flat side attached firmly to the ectosteal plate, its posterior lower edge to the endosteal process, and its lower edge extending downwards over Meckel's cartilage to a considerable extent. The tendon is attached near its middle.

Philypnus dormitator.

The sesamoid articular is a rather small triangular bone, situated on top of Meckel's cartilage well in front of the endosteal process, and slightly against the ectosteal plate.

THE DISCOCEPHALI.

Echenis naucrates.

The endosteal process is obscure. The sesamoid articular is a large, flat bone of rather complex outline, attached against the articular just above and slightly covered by Meckel's cartilage.

THE TRICHODONTIDÆ.

Trichodon trichodon.

The sesamoid articular lies just in front of the endosteal process between Meckel's cartilage and the ectosteal plate.

THE LATILIDÆ.

Lopholatilus chamoeleonticeps.

The sesamoid articular is a rather large, thick bone wedged between the ectosteal plate and the endosteal process.

THE BATHYMASTERIDÆ.

Bathymaster signatus.

The sesamoid articular is here essentially as in *Trichodon.*

THE URANOSCOPIDÆ AND TRACHINIDÆ.

Uranoscopus scaber, Trachinus radiatus.

The large sesamoid articular is broadly attached against the ectosteal plate with its lower surface resting on the endosteal process and Meckel's cartilage.

THE BLENNIOID FISHES.

Lumpenus anguillaris, Cebedichthys violaceus, Ziphidion mucosum.

The sesamoid articular is large and attached closely to the ectosteal plate, resting at its lower edge on Meckel's cartilage, and sometimes on the endosteal process; in *Lumpenus* it rests equally on the cartilage and process; in *Cebedichthys* it is only slightly in contact with the process; in *Ziphidion* it is remote from the process.

Heterostichus rostratus.

In this the sesamoid articular is small and against the ectosteal plate remote from the endosteal process, while Meckel's cartilage covers its inner surface.

Anarrichthys ocellatus.

This has the sesamoid articular situated as in *Lumpenus,* but it is much larger, roughly elliptical in outline, and very thick, with its thickness extending to its edges.

THE ZOARCIDÆ.

Lycodopsis pacificus, Lycodes brevipes.

The sesamoid articular is long and rather thick. It is wedged in between the ectosteal plate and Meckel's cartilage, extending up, however, considerably above the latter. Its posterior end extends a little behind the anterior end of the endosteal process.

THE ANACANTHINI.

Melanogrammus aeglifinus, Brosme brosme.

The sesamoid articular is large and is attached against the ectosteal plate just at the end of the endosteal process. It extends downward somewhat behind Meckel's cartilage, but its bulk is above the cartilage and arches over its upper surface.

Microgadus tomcod.

The condition of the sesamoid articular is most surprising, for it is apparent that part of it at least is endosteal in origin, ossifying directly from Meckel's cartilage. For a short distance in front of the endosteal process Meckel's cartilage is as usual, then it is abruptly ossified in a rod of bone in front of which, as it runs toward the dentary, it is again cartilaginous. The posterior outer part of the ossification is enlarged against the ectosteal plate, and to this enlargement the stout adductor tendon is attached. It appears evident that the enlarged outer portion is the usual sesamoid articular, and that Meckel's cartilage in ossifying has become anchylosed with it. The part anterior to the enlarged portion is a white, poorly organized, granular bone, but at the enlargement it is clear and dense. Several speciments between 8 and 10 inches in length were examined, and considerable variation found in the length of the ossified portion of Meckel's cartilage.

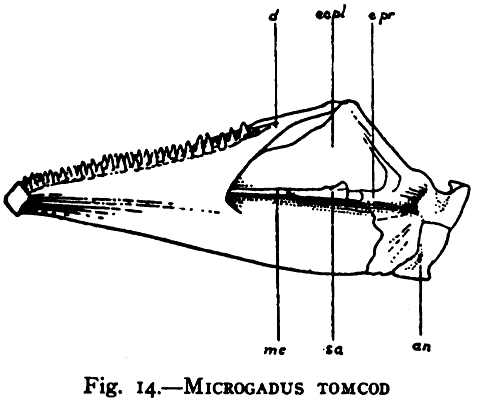

Fig. 14.—Microgadus tomcod
an, angular; *d*, dentary; *ecpl*, ectosteal plate; *epr*, endosteal process; *mc*, Meckel's cartilage; *sa*, sesamoid articular.

Gadus callarias, Pollachius brandti.

A small part of Meckel's cartilage is replaced by the sesamoid articular and the cartilage is unossified before and behind it. The outer part of the ossification spreads out in a broad plate of bone over the ectosteal plate, where it is firmly attached. This outer part resembles the sesamoid articular as found in many forms. A stout tendon is attached to a rather wide base formed by both the part replacing cartilage and the part against the ectosteal plate. The endosteal process is ossified on the surface only, for a considerable space at its anterior end leaving cartilage within.

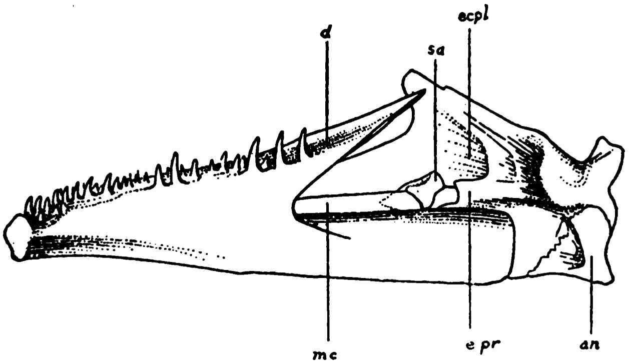

Fig. 15.—GADUS CALLARIAS
an, angular; *d*, dentary; *ecpl*, ectosteal plate; *epr*, endosteal process; *mc*, Meckel's cartilage; *sa*, sesamoid articular.

THE HETEROSOMATA.

Psettichthys melanostictus, Eopsetta jordani, Parophrys vetulus, Citharichthys sordidus.

The sesamoid articular is against the ectosteal plate directly in front of the endosteal process, and covered more or less by Meckel's cartilage. In *Parophrys* it is larger than in the others and more disk-like.

Usinosita japonica.

The endosteal process is scarcely developed, and the endosteal part of the articular consists of little more than enough bone to form the concavity for the articulation of the condyle of the quadrate. Articulated to this bone directly in front of the concavity is a large sesamoid articular which rests broadly on Meckel's cartilage.

THE PEDICULATI.

Antennarius sp.

The small sesamoid articular rests against the ectosteal plate directly in front of the endosteal process, and is nearly covered from sight by Meckel's cartilage.

Ogcocephalus radiatus.

The sesamoid articular is broad and disk-like, and is attached tightly against the ectosteal plate and the upper surface of the endosteal process, while anteriorly it rests on the surface of Meckel's cartilage.

SUMMARY

Specimens from nearly every important group of fishes have been examined and are herein reported upon. The sesamoid articular was found in every group that is more highly specialized than the primitive Clupeoid fishes as well as in one of the Ganoids, *Amiatus,* though here its identity may be open to some doubt.

The sesamoid articular is variable in size and somewhat in position, though it is always in relationship with Meckel's cartilage—usually in very close association with it. Typically, as in the perch-like fishes, it is rather small and more or less covered by Meckel's cartilage. Sometimes, as in *Albula,* it is as large as the endosteal process; or, as in some of the Synentognathous fishes, it is so large that it projects above its surrounding elements, so that it is visible from the outer surface. Sometimes it is loosely attached to the mandible and is easily pulled away with its tendon. Sometimes it is attached to the mandible by a dentate suture and is disarticulated with difficulty. Usually it is more or less broadly attached to the ectosteal plate of the articular, but sometimes only narrowly attached, and occasionally scarcely, or not at all, in contact. Sometimes it lies saddle-like over the top of Meckel's cartilage, remote from any bone. It is variable in its connection with the endosteal process, but as the attachment may depend upon the extent of the ossification of Meckel's cartilage to form the process, this is without significance. In at least one case (*Leiognathus*) two equally stout, dense tendons join the sesamoid articular at a considerable distance from each other.

The sesamoid articular is doubtless, as its name implies, a sesamoid bone. This is especially well shown in *Spheroides annulatus,* where the adductor tendon has obviously ossified for a short space, leaving an interval of tendon between the ossified portion and the mandible. Intermediate between this condition and the more typical condition is the sesamoid articular of *Ovoides,* a close relative of *Spheroides,* where the interval of cartilage between the tendon bone and the mandible has disappeared and the former has spread out to some degree on the mandible.

On the other hand *Microgadus* and *Gadus* appear to have the bone partly endosteal in origin, or at least a bone endosteal in origin has become anchylosed with it. In *Gadus,* however, it is not altogether clear

that the sesamoid articular in replacing a section of Meckel's cartilage is necessarily the ossified cartilage. The sesamoid articular may have surrounded Meckel's cartilage, and developing from without inward may thus have replaced it. The beginning of such a process is suggested by *Melanogrammus,* and other forms, where the sesamoid articular arches over the upper surface of Meckel's cartilage. Such, however, does not account for the condition in *Microgadus* (*M. tomcod*), where the cartilage is ossified in a rod in front of the sesamoid articular.

The fact that ossification has taken place in Meckel's cartilage suggests an apropos observation of Dr. Ridewood's (Proc. Zool. Soc. Lond., 1904, p. 56) in regard to bones that are both ectosteal and endosteal in origin, whether the two sorts are anchylosed or distinct from each other. "The endosteal ossification has been set up in sympathy with the ossification taking place in the dermal tissues. The process of ossification is infectious, if one may employ such a term in this connection."

It is significant that in every case the sesamoid articular is in close relationship with Meckel's cartilage (or with the endosteal process, which is ontologically the same). Even in cases where it has developed upwards towards the coronoid region it still retains its connection with the primitive cartilage.

Moreover, in some cases, as *Albula,* it is strikingly like the endosteal part of the articular, and appears (at least superficially) to bear the same relationship with Meckel's cartilage—the cartilage apparently issuing from it as it does from the endosteal process.

Other tendons than that to the sesamoid articular join the mandible at various places, sometimes originating on the same muscle and same place as does that to the sesamoid articular; but they are nearly always less compactly organized, though often they are larger. There is never a second sesamoid articular developed for these other tendons, though they may appear to be more important in doing the greater share of the work.

The sesamoid articular is of no use in taxonomy of groups larger than species, as it often differs within the genus. To pronounce upon its value in differentiating species, or upon its individual variation, would necessitate much more work within narrower limits than has been here undertaken.

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A Study of Verbs

Compounded with Aus, Ein, etc.
as contrasted with those Compounded with
Heraus, Hinaus, Herein, Hinein, etc.

BY

CHARLES REINING
Instructor in German

STANFORD UNIVERSITY, CALIFORNIA
PUBLISHED BY THE UNIVERSITY
1916

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PREFACE

The following study, which was undertaken at the suggestion of Professor George Hempl, is meant as a contribution to lexicography in general, and in particular to that branch of it coming under the head of semasiology. While the investigation is based on a certain group of verbal compounds, word-composition as such is treated only in so far as it has a direct bearing on the matter in hand. I present my material and the deductions drawn from it in the hope that it may add to the knowledge of some of the principles underlying semantic changes in language. Only five separable prefixes as elements of compound verbs are considered. Others will be treated at a future time.

I wish to express my sincere gratitude to Professor William A. Cooper, who in the absence of Professor Hempl gave me unstintingly of his time and advice and who was ever ready to discuss with me all problems arising, of which there are many in a field still comparatively new. I also acknowledge the counsel and advice given me by Professor Karl G. Rendtorff. I owe much to my wife for her painstaking assistance in typewriting and proofreading.

C. R.

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INTRODUCTION

As the title of this investigation indicates, it is a study of the difference between verbs compounded with certain separable prefixes and those compounded with an augmented form of the same prefixes. The purpose is two-fold, viz., to investigate the difference in function between the simple and the double prefix, and to trace the corresponding differences in semantic development. I have found it necessary to limit myself to such verbs as form compounds with the simple prefixes 'aus,' 'ein,' 'ab,' 'auf,' 'an,' and also with the double prefixes 'heraus,' 'hinaus,' 'herein,' 'hinein,' etc.

In the older Germanic languages, the double prefix is entirely missing. The simple adverbial particles, which, as original adverbs of direction were used with verbs of motion only, sufficed to express the idea contained in the modern German double prefixes. This is made clear by the quotations from Old High German, Middle High German and early New High German writers, which will be found in the first part of each chapter. Old High German contains less than a half dozen verbs having a double prefix of the type considered in this investigation. (Cf. §§ 22, 63, 99, 140.) It will be noticed that neither 'herab' nor 'hinab' was found as a verbal prefix before the Middle High German period, while 'heran' is not recorded before the 17th century.

Altho there is an increase in the spread of these double prefixes during the Middle High German period, it is evident that they are still new formations; and in most cases the demonstrative force of 'her' and 'hin' is evident. But with the beginning of the New High German period, especially in the writings of Luther, the double particle appears thoroly established, as is apparent from the phonetic decay of 'heraus,' 'herein,' to 'raus,' 'rein,' etc., and 'hinaus,' 'hinein,' to 'enaus,' 'enein,' and even to 'naus,' 'nein.' Since that time the double prefix has steadily gained ground, usurping the function formerly possessed by the simple particle. At the present time, the simple prefix with its original force has entirely lost its power of entering into new formations, this office being now performed by one of the double prefixes. To determine the factors underlying the spread of the double prefix is one of the problems which I have attempted to solve in the present study.

The adverbial particles were originally prefixed to verbs of motion only, motion being taken in its broadest sense. The particle indicated the direction of the motion denoted by the verb. The relation of the motion to the speaker was determined from the context or situation. The 'her' and 'hin' of the new compound prefixes which supplanted the old simple prefixes are derived from an old demonstrative stem '*hi.' But the expanded form acquired eventually the identical force shown to have earlier been possessed by the simple particle.

It is clear that at the time when the double particle first makes its appearance, the simple prefix is undergoing a functional weakening. This deterioration of the particle is the result of its use as a prefix; for it is a linguistic law, that any combination or group of words occurring frequently together, comes to be a conceptual unity, the elements of which sacrifice their individuality in the group meaning. Thus it happens that a compound does not represent the sum of all the qualities of its component parts. On the contrary, each added element subtracts from the original value of the other parts in that it limits them.

Word-composition is a matter of psychology. It is a semasiological process. Mere juxtaposition of its parts never results in a compound unless there is also a unity of meaning, altho all compounds originated in juxtaposition of their elements.

Whenever an old word no longer clearly and effectively expresses an idea for which it formerly stood, some other word is employed to perform the function lost by the older term. In the case in hand, it is not a new word that is introduced, but a second element is added to the old, weakened word to revivify it. For a while the old and the new expression remained with practically parallel force. Then, as the old term continued gradually to lose its function, the new compound prefix came to occupy the field surrendered by the old simple particle.

It is instructive to follow the spread of the double prefixes from their first appearance in the 9th century to the present time, when they have entirely usurped the function once possessed by the simple prefix. During the period from the 9th to the end of the 15th centuries, verbs compounded with any of the double prefixes appear as isolated neologisms. It is evident from their use that they were not felt to possess a function differing from the simple prefixes. For a time the new elements appeared loosely connected with the old particle which they strengthened. They might precede or follow the particle. (Cf. § 26.) In fact, it would appear that people were still conscious of a demonstrative force contained in 'her' or 'hin.'

By comparing Luther's translations of Biblical passages with translations of the same passages in Tatian or Otfried's Gospel Harmonies, we find that Luther generally employed a verb with a double prefix where the Old High German writers used only the simple particle prefixed to the verb. This and the great increase of verbs with double prefixes, warrants us in assuming that the old simple form of the prefix was felt to be too weak to express the desired idea. The great disparity between the frequency of verbs compounded with double prefixes during the centuries preceding the New High German and the number found in the earliest records of the latter period, is significant of the linguistic attitude of the time. One of the chief factors operating toward the functional weakening of the adverbial particles was the semantic change these latter underwent as parts of a compound. The Middle High German classical period was especially prolific in new meanings given verbs by their adverbial prefixes.

As was stated, the chief factor active in limiting the use of the simple particle was its semantic development as part of a compound. Paul complains of the lack of data on the verbal compounds with the particles 'ab,' 'ein,' etc.[1] He requires the history of each word in order fully to understand its development. In this study, five of the particles are thus treated, and a history and explanation of the semantic changes has been attempted so far as this was possible from the available material. Since I am dealing with the prefix as an element of a compound, the history of the particle as an independent word need not be treated here. The change which its union with a verb has given the composite group will be treated. In many instances the verbs have undergone semantic changes independent of any formal elements added, as *e.g.*, 'lesen' $=$ 'to read' $<$ 'to collect'; 'write' $<$ 'writan' $=$ 'to scratch,' etc. Such changes do not properly come within the scope of the present study.

A compound is always a union of two elements, each of which may itself be a compound, tho in the new compound it is considered as a unit. For example, in 'Oberbefehlshaber,' 'Ober' is one unit, and 'befehlshaber,' altho composed of a number of elements, is the second unit. The same holds good for verbs compounded with 'heraus,' 'hinaus,' etc. So long as either of the particles 'her' or 'aus' was thought of as independent, it did not form a compound with the verb.

The act of entering into a composition has important consequences.

[1] Hermann Paul, *Über die Aufgaben der wissenschaftlichen Lexicographie.*

Oertel says: "Whenever adjacent concepts are condensed into one, the newly created conception contains a larger number of elements than either of the two original concepts, and its sphere is therefore narrower. This fusion of concepts finds its linguistic expression in two ways: namely, first by reduction; second, by the complete loss of one of the names of a concept."[2] Consequently a compound never has exactly the same meaning as the sum of its component parts.[3]

Tho at times one or the other of the elements of a compound may retain its original meaning longer than such element when used alone (cf. 'gift' in 'Mitgift'), the general tendency of the compound as a whole, is to change its meaning more than either component does. This is what has taken place in the majority of verbs compounded with one of the adverbial particles. Verbs compounded with one of the double prefixes have not undergone changes to the same extent, for the simple reason that the formations are still too new to have had time to adopt new meanings.

Concerning laws governing semasiology, Meyer quotes Thomas Pillet: "Il n'y a pas de lois en sémantique," concurring in this opinion, and adding that semasiology must be determined for each word.[4] Altho it is true for a vast majority of semantic changes that they are not governed by laws, as is the case with phonology, the material offered in the body of this investigation seems to justify some general principles, at least so far as these compounds are concerned.

As all of the particles treated were originally adverbs of direction, obviously they were compounded with verbs of motion only, motion being understood in its broadest sense. The motion denoted by the verbs may be compared to that of a rolling ball, the motive force being contained in the verb, while the direction of the movement is determined by the adverbial particle. For example, the verb 'gehen' denoted a very general progress, but no starting point, goal or direction of the motion is indicated. The addition of the prefix 'aus,' however, makes of the general motion a special one. Altho the adverb originally denoted only an out-

[2] Hanns Oertel, *Lectures in the Study of Language*, p. 312. New York, 1902.

[3] "Sämtliche Komposita stellen die unlösliche Einheit zweier Begriffe dar. Eine solche würde nicht zustande gekommen sein, wenn sie nicht etwas anderes zum Ausdruck bringen sollte, als die lose Verbindung derselben Begriffe, welche durch andere Ausdrucksmittel, z.B. Flexionsform, bewirkt wird. Die Komposita haben einen eignen, durch kein anderes Mittel genau ersetzbaren Wert für den Satz." B. Delbrück, *Grundriss der Vergleichenden Grammatik*, vol. 5, p. 140.

[4] R. M. Meyer, *Bedeutungssysteme*, in *Kuhns Zeitschr.* 43, 353.

ward direction of the motion, it shows that the starting point of the progress indicated by the verb is within enclosed limits and the goal is outside of these limits. The opposite signification is given the verb by the prefix 'ein.'

The adverb 'ab' is more general in its application. It only vaguely implies a starting point, and indicates no goal of the motion. The verb 'gehen' with the prefix 'ab' meant originally 'to go away from,' without further specifying or limiting the progress. Similarly 'auf' prefixed to 'gehen' denoted that the direction was very generally upward. To come back to the figure of the rolling ball, in the one instance the ball rolls from an enclosed space out of this, and stops, having reached its goal ('aus'). In the second case the ball rolls into an enclosed space from outside, and stops, 'ein' indicating the goal. In the third case the ball starts from some surface and rolls away from this ('ab'), stopping when the impetus given by the verb is exhausted. The action is reversed in the case of verbs compounded with 'an.' 'Auf' would be represented by an upward progress of the ball, that is, to a position on a higher level than that from which the ball started. The duration of the progress, as in the case of verbs with 'ab,' is determined by the impetus given by the verb. From the above it may be seen that we have two distinct types of adverbs, the first indicating a starting point and a goal, the second showing merely a general direction. They must, in consequence, be treated separately.

As pointed out, the verbs with which the particles mentioned above could be compounded denoted motion. Furthermore, they were durative verbs. In the words of Spinoza, "Nothing is constant but change"; hence we may assume that a motion is not identical during the entire duration of the action. There are innumerable changes in the situation as an object proceeds from one place to another. There are certain barriers that must be overcome. To revert once more to the figure of the rolling ball, this may be deflected from its original course. The situation is interpreted in terms laid down by the person uttering the sentence,—starting the ball on its course, so to speak. As the ball passes away from the speaker, its relation to him is continually changing; but the transitions are so gradual that they are scarcely perceptible, except at certain points in the progress. At these points the transitions are so abrupt that the relation between the person and the ball is no longer the same. For example, let the direction be outward. The ball starts in the same enclosure with the person. Obviously, at the moment the ball leaves the

enclosure it no longer has the same relation to the person which it had up to that time; in fact, so far as the person is concerned, the ball has passed out of existence. Furthermore, since the outside is the goal of the action denoted by the verb compounded with 'aus,' this action is completed the moment the object has reached the outside. It is from a situation like this, that the force 'to complete the activity' or 'put an end to the object' is derived. "Das Feuer *geht aus*," "ein Lied *aussingen*," "den Tanz *austanzen*," etc. (Cf. §§ 12-14.)

But the speaker need not necessarily identify himself with the interior of the enclosure from which the motion starts. He may be on the outside of the enclosure; in which case the progress of the motion is toward him. The ball is approaching the speaker, but it is only in a very distant relation to him so long as it is moving toward the exterior. Not until it reaches the outside does it enter into close relation with him. As a rule, it is only then that its existence becomes a matter of observation to him. In other words, the activity, as well as the object, begins or has its origin at the moment the ball exits from within. *E. g.*, "ein Geheimnis *kommt aus*," "von einer Sache *ausgehen*," (cf. § 17). In this connection it is instructive to notice that 'heraus' may also give this force to a compound in which it is used, whereas 'hinaus' never has this power.

In view of this force given to verbs by the addition of 'aus' one might expect a corresponding opposite force to result from a combination with 'ein,' for the functions of these two particles are to indicate exactly opposite directions. This is just what has been found. More than that, whereas compounds with 'aus' with the force 'to end,' occur before compounds with the meaning 'to begin,' the reverse is true of compounds with the prefix 'ein.' Examples of compounds with 'ein' denoting the beginning of an action or a thing are: 'einführen,' 'eingehen,' 'einleiten' (cf. § 50). "Eine Tätigkeit *einstellen*," "eine Zeitschrift *geht ein*," etc., contain examples of compounds with 'ein' meaning 'to end' (cf. § 54).

A ball rolling away, or up from its original position, is not subject to such a complete transition from its former state as one rolling out of or into an enclosure. It never, at any point of its course, enters into an entirely new relation to a former position, until its progress is completed, that is, when a position sufficiently 'off' or 'up' has been reached. The emphasis in verbs compounded with 'ab' or 'auf' is on the time when the progress in a certain direction is completed, the important thing being the perfection of the action. This explains the semantic development of the

following compounds with 'ab': "die Uhr *läuft ab,*" "eine Schande *abbüssen,*" "eine Sitte *abschaffen.*" (For further examples cf. § 88.) Compounds with 'auf' showing the same development are: 'aufbrennen,' 'aufessen,' etc. (Cf. § 127.)

Beside the semantic changes of these compounds caused by the centering of the emphasis on some particular point of the progress denoted by the verb, many meanings have become attached to them by virtue of the fact that they are frequently used with reference to some particular situation, that is, their use has become specialized.[5] In fact the whole process of semantic changes noted in this study is a process of specialization. Even in the development discussed on the preceding pages, the changes in meaning are the result of the emphasis being shifted from a general to a special activity. The only class of compounds not coming under this head are those verbs which have shifted from denoting the original action to indicating the result of the action. Such compounds are: 'aufhören,' 'aufhalten,' etc. (§ 121), 'aufmachen,' meaning 'to open' (§ 120), 'sich abarbeiten' (§ 92), 'sich einarbeiten' (§ 58). All other semantic changes within the scope of this investigation had their rise in figures of speech.

Semantic changes, like all other linguistic developments, are chiefly a matter of time and circumstances. It is safe to say that virtually every word undergoes changes of meaning as time goes on. Conditions under which it is used may hasten or retard the development. From the nature of their use, nouns are less subject to change than verbs. Yet, even such words as 'Meer,' 'Fluss', etc. awaken different ideas in the minds of different people. 'Phagos,' the Greek cognate of our word 'beech,' designated an oak tree for the former people.

The principal change which the demonstrative particle in composition has undergone, is a weakening from its demonstrative function to

[5] Regarding this type of specialization, Paul says: "Dieselben Momente [accompanying circumstance], durch welche ein Wort konkrete Beziehung erhält, dienen auch zur Specialisierung der Bedeutung. Ohne Mitwirkung besonderer Umstände wird man, wenn man ein Wort hört, zunächst an die gewöhnlichste unter den verschiedenen Bedeutungen desselben oder an die Grundbedeutung denken. Beides fällt häufig zusammen. . . . Unterhalten sich Tischler, Jäger, Ärzte oder sonst Leute von einerlei Beruf unter einander, so sind sie dazu disponiert alle Wörter von derjenigen Seite her aufzufassen, die ihnen dieser Beruf nahe legt. Von grosser Bedeutung ist die Verbindung, in der ein Wort auftritt. Durch sie können die verschiedenen Möglichkeiten der Auffassung eines Wortes auf eine einzige beschränkt werden. Cf. "ein schwarzes Mal," "ein zweites Mal," "ein reichliches Mal." *Principien der Sprachgeschichte*, p. 81.

that of an intensifying element. Wherever compounds with the double prefix have undergone a change of meaning, it has been as a result of this intensifying force of 'hin' or 'her.'

The material upon which this investigation is based has been drawn largely from dictionaries, which I have supplemented wherever they seemed inadequate. In the discussion of the semantic development of compounds I have attempted, in every case, to give the earliest quotation in which a verb compounded with a given prefix had developed a certain meaning. The quotations in each section are arranged as nearly chronologically as possible.

Since none of the German dictionaries treat their material from a historical standpoint, and since only the date of the edition of a work abstracted is given by them, it was no small task to date all of the works cited. Thruout I have given only approximate dates, since an absolute time for the first use of a word can be definitely determined in but rare instances. For the older German writers, the exact dates of their activity are seldom known, while in the case of modern writers, the particular work in which a word appears for the first time is largely a matter of chance. Altho many of the words accredited to Goethe were not used by him until after the beginning of the 19th century, I have everywhere listed Goethe as an 18th century writer, for it was in that century that he acquired and developed his linguistic tendencies.

The body of this work is divided into five chapters, in each of which one of the adverbial particles and its augmented forms with 'her' and 'hin' are treated. The chapters are subdivided into four parts. In the first I have treated the verbal compounds with the simple prefix still having its original force; in the second I take up the development of new meanings given the verbs by the prefixes; in the third and fourth, verbs with the double prefixes are similarly treated. It should be added that only those verbs compounded with 'aus' which also have a parallel form in 'heraus' or 'hinaus' are considered. The same restriction holds for the other prefixes.

CHAPTER I.
AUS, HERAUS, HINAUS

PART I.

'AUS' WITH ITS ORIGINAL FORCE

§ 1. Originally 'aus' was an adverb which came in time to assume the function of a preposition as well. As an adverb it had the force 'out of', 'out from within'. This original force is still preserved by the Gothic adverb 'ut', 'us', and the Anglo-Saxon 'út', Modern English 'out'. In Modern English we say: "He came out when we called to him." A German would have to say: "Er kam *heraus,* als wir ihm riefen." That is, in German the particle 'aus' needs some element to strengthen it in order to express the idea for which the simple 'out' suffices in English. This weakening of the prefix in German is of comparatively recent date. Where the older German language used simply 'aus' compounded with the verb, it is now frequently necessary to substitute one of the double prefixes 'heraus' or 'hinaus'. Examples of this old force of 'aus' follow.

Otfried (9th C.): *fuar* er fon theru burg *uz* zi themo druhtines hus (2, 11, 4).

ûzstiaz er se gilicho ioh filu kraftlicho (2, 11, 10). Cf. Joh. 2, 15: trieb sie Alle . . . hinaus.

dreip se al thanan *uz* (4, 4, 65). Cf. Mat. 21, 12: trieb sie hinaus.

Tatian (9th C.): Lazarus, *cum ûz* (135, 26). Cf. Joh. 11, 43: kom heraus.

sênu ih *leitu* inan iu *ûz* (197, 2). Cf. Joh. 19, 4: führe ihn heraus.

thâr ist thanne uuoft inti zenô stredunga, mittiu ir gisehet Abrahâm . . . ingangan in gotes rîchi, iuuuih *ûztrîban* (113, 2).

inti *vvurpfun* in *ûz* (132, 20). Cf. Joh. 9, 34: Stiessen ihn hinaus.

Pfaffe Konrad (12th C.): di gîsel hîz er *ûz fûren* (M.).

Lamprecht (12th C.): die wartman *ûz* do *draveten* (Alexanderl. 4254, L).

Nibelungenlied (12th C.): sô liep dir sî ze lebene, sô *trit* vil balde *ûz* an den sant (1558, 4).

Walther von der Vogelweide (12th C.): ein schar *vert ûz*, diu ander in, naht unde tac (Bartsch 21, 77).[6]

Hartmann von Aue (12th C.):

dâ sach er zuo im *ûz gân*
eine riterliche magt (Iwein, 1152).

nû was der leu *ûz komen*
als ir ê habt vernomen,
dâ er dâ inversperrt wart (Iwein, 7727).

In all of the examples cited above, it would now be necessary to substitute 'heraus' or 'hinaus' for the Old High German and Middle High German 'uz'. In many instances a modern German compound with 'aus' exists, but it has usually acquired a meaning different from that expressed by the compound with 'heraus' or 'hinaus'.

§ 2. But even in New High German the number of verbs compounded with the simple 'aus' greatly exceeds those compounded with 'heraus' or 'hinaus'. They may be divided into two classes:

1). Those in which the prefix retains its original force.

2). Those in which the prefix has developed a specialized meaning.

The prefixes of the first class have asserted their original meanings under rather adverse conditions. In the first place, we have seen that in the examples quoted above (§ 1) 'uz' has become so weakened, that for our present "Sprachgefühl" we require the addition of 'her' or 'hin' to express the old idea 'out of'. Furthermore, since 'heraus' and 'hinaus' have become recognized as prefixes expressing a certain idea, and since 'aus' has assumed a specialized meaning in many instances, we are surprised that 'aus' has kept its old function in any of the compounds. This may in part be accounted for by the fact that the preposition 'aus' still exists as an independent word with the old force of the adverb, namely, 'out of'. But, on the other hand, altho the preposition has aided in preserving a feeling for the old force of the prefix in existing compounds, the prefix itself is no longer capable of entering into new formations, when the meaning 'out of' is to be expressed. Nearly all of those compounds with 'aus' in which the prefix still shows its original force, are stereotyped expressions coming down from a time when the old concrete idea was still distinctly felt. The following examples show this clearly.

[6] The modern German 'ausfahren' has become specialized.

Otfried (9th C.): maht lesan . . . uuio *fuarun* thiu diufil ir *uz* (3, 14, 53).

In modern German we should probably translate this passage: 'Die Teufel verliessen sie.' In Luther's translation of the Bible we find: "Das Fieber verliess sie." (Cf. Mat. 8, 15.) In another passage, however, Luther has this sentence: "Fahre aus, du unsauberer Geist, von dem Menschen." (Cf. Mk. 5, 8.) Here we have 'ausfahren' preserved in a very old compound. Spirits, both good and evil, were believed to dwell within human beings. One means of exit was the mouth, hence there was a concrete idea of the spirit coming out of the human being. That Luther no longer visualized this passage of the spirit out of the man is evident from the phrase, "von dem Menschen." The sentence means to us, and no doubt already meant to Luther, 'verlasse den Menschen'. Hence Luther does not substitute 'heraus' for 'aus'. 'Ausfahren', 'austreiben', etc., are old compounds referring in this connection to the exit of spirits. It is interesting to compare the Gothic translation of the passage from Mark. Wulfilas translates: "usgagg, ahma unhrainja, us þamma mann."

While Wulfilas seems still to adhere to the old conception of the unclean spirit coming out of the man, he already feels the necessity of supporting the compound 'usgagg' with a preposition 'us', to express more clearly the idea of motion from within outward. In other words, even at the time of the writing of the Gothic Bible, the force of the prefix in 'usgagg' was weakening.

Otfried (9th C.): uuard tho mennisgen uue, thaz er nan [den Apfel] *uz* thoh ni *spe* (2, 6, 27).[7]

Genesis (11th C.): Adam slief unde lach unz im got ein rippe *uoz prach* (L.).[8]

Walther von der Vogelweide (12th C.): so man iuch *uz* ze boten *zendet* (M.).

Friedrich von Husen (12th C.): mochte ich dir dîn krumbez ouge *ûz gestechen* des hât ich reht . . . (Bartsch 8, 45).

Hartmann von Aue (12th C.): (der lewe) *souc* im *ûz* daz warme bluot (Iwein 3899).

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[7] Originally 'ausspeien' no doubt had a distinct reference to a spitting out of the mouth, and the full force of 'aus' was felt. That idea has become weakened, however, to 'to spit away', 'dispose of something by spitting it from one'. Hence the demonstrative particle has not been added.

[8] Altho we would now employ some other word in this connection, 'ausbrechen' is still common in phrases like "einen Zahn ausbrechen."

Gottfried von Strassburg (13th C.):

dannoch vor naht dô wart der schal
in dem lande fliegende überal,
daz der stolze Kâedîn
ûz geriten solde sin
mit offenlicher reise (Trist. 18840).

§ 3. Another group of words coming under the head of stereotyped forms, is the one in which 'aus' and 'ein' occur as a fixed formula. As such, they have become fossilized and preserved in their old form and with nearly their original function. The prefix in this section is generally compounded with verbs having the idea 'to go' or 'to come'.

Tatian (9th C.): inti *ingêt* inti *ûzgêt* inti findit fuotrunga (133, 10).

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Ezechieles porte durch die der künec herliche wart *ûz* und *în gelan* (M.).

du wilt gewalteclîchen *gan*
zu mînen herzen *ûz* und *în* (M.).

Luther (16th C.): Ich bin die Thür; so Jemand durch mich eingeht, der wird selig werden, und wird *ein-* und *ausgehen* und Weide finden (Joh. 10, 9).

Jericho aber war verschlossen und verwahrt vor den Kindern Israel, dass Niemand *aus-* oder *einkommen* konnte (Jos. 6, 1).

Opitz (17th C.): Viel Sachen *fallen* mir bei andern Sorgen *ein,* doch *fällt* mir bald auch *aus,* was ich mir vorgenommen (DWb.).[9]

Friedrich v. Logau (17th C.):

Bei Hofe lernt man merken, dasz die die Besten sein
Die sonst nichts thun noch künnen, als *schlucken aus* und *ein* (DWb.).

Adelung (18th C.): ausfliegen, mit dem Hülfsworte sein = hinausfliegen, doch nur in der Redensart *ein-* und *ausfliegen.*

§ 4. Here also belong the words expressing the idea 'to undress' or, according to the older conception, 'to get out of one's clothes'. All of the verbs in this class are examples of metonymy when the clothes are the object of the sentence. The metonymic development was aided by the group of verbs compounded with 'ab' having the same general meaning.[10]

[9] 'Ausfallen' is no doubt a humorous coinage formed in analogy to 'einfallen'.

[10] The latter took their departure from such a sentence as: "Ich *bringe* daz harnasch *abe* im." (Cf. Parz. 156, 17.) In such cases the object of the preposi-

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Matthison (18th C.): Jetzt fing sie an die Kleider *auszuschleifen* (S.).

Bettine v. Arnim (19th C.): Er meint immer ich habe die Kinder schuhe noch nicht ausgetreten ('ablegen', abziehen', DWb.).

Part II.

New Meanings Developed by 'Aus'

§ 5. In all of the quotations cited thus far, the old force of the particle 'aus' was still apparent. Turning now to a discussion of the figurative meanings of the prefix 'aus', an examination of any of the larger German dictionaries shows that this prefix has developed a number of meanings not originally possessed by it. On the one hand it acquired specialized force and on the other it deteriorated to express a very general idea. But none of these developments are treated historically. Not even the excellent "Deutsches Wörterbuch" of Hermann Paul consistently attempts a chronological consideration of the semantic development of these or any other words. Yet the period when a certain linguistic phenomenon took place is of extreme importance for a correct appreciation of the language and thought of that time.

§ 6. As will be shown later (§ 22), Otfried felt called upon in two instances, to support the prefix 'uz' by the old demonstrative particle 'her' or 'hin' in translating passages where Tatian used the simple prefix 'uz'. And yet, even for Tatian, the old force of 'uz' was beginning to weaken, as is apparent from the following sentence:

ûzgieng fon fater, quam in uueralt (Tatian 175, 6).

Luther translates this passage: "Ich bin vom Vater ausgegangen" (Joh.

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tion could be dropped without danger of ambiguity, as the context would prevent this. There would be even greater tendency to omit the object of the preposition if it were identical with the subject of the sentence. The result was a sentence of the type: "ouch *zôch* im mêr gewandes *abe*, manec wol geborner knabe" (Parz. 243, 17). 'Im abe ziehen' is identical with 'abe im ziehen'. (Cf. § 81.)

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in dem lande fliegende überal,
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PART II.

NEW MEANINGS DEVELOPED BY 'AUS'

§ 5. In all of the quotations cited thus far, the old force of the particle 'aus' was still apparent. Turning now to a discussion of the figurative meanings of the prefix 'aus', an examination of any of the larger German dictionaries shows that this prefix has developed a number of meanings not originally possessed by it. On the one hand it acquired specialized force and on the other it deteriorated to express a very general idea. But none of these developments are treated historically. Not even the excellent "Deutsches Wörterbuch" of Hermann Paul consistently attempts a chronological consideration of the semantic development of these or any other words. Yet the period when a certain linguistic phenomenon took place is of extreme importance for a correct appreciation of the language and thought of that time.

§ 6. As will be shown later (§ 22), Otfried felt called upon in two instances, to support the prefix 'uz' by the old demonstrative particle 'her' or 'hin' in translating passages where Tatian used the simple prefix 'uz'. And yet, even for Tatian, the old force of 'uz' was beginning to weaken, as is apparent from the following sentence:

ûzgieng fon fater, quam in uueralt (Tatian 175, 6).

Luther translates this passage: "Ich bin vom Vater ausgegangen" (Joh.

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tion could be dropped without danger of ambiguity, as the context would prevent this. There would be even greater tendency to omit the object of the preposition if it were identical with the subject of the sentence. The result was a sentence of the type: "ouch *zôch* im mêr gewandes *abe*, manec wol geborner knabe" (Parz. 243, 17). 'Im abe ziehen' is identical with 'abe im ziehen'. (Cf. § 81.)

forsake it, so to speak. Altho this meaning is not recorded from Old High German sources, Middle High German shows it at a very early date.

Genesis (11th C.): so dir diu sêle *ûz gêt* (M.).

Deut. Gedichte d. 11ten u. 12ten Jh.: sint *uz* von gote *gezogen* ('haben sich von ihm entfernt', M.).

Wolfram v. Eschenbach (13th C.):

er *nam* sich vor den andern *ûz*
do'r ûfem helme ersach den strûz (Parz. 72, 29).

dâne *scheide* ich *ûz* niht mêre ['dabei bleibe ich'] (Parz. 269, 29).

Wirnt v. Gravenberg (13th C.): si waren niender *ûz getreten* ir zuht stuont an der maze zil ('von dem Rechten abgewichen', M.).

Das alte Passional (13th C.): sin wec besîtzen *ûz trat* (M.).

Konrad v. Würzburg (13th C.): sîn valsch wart *ûzgebrennet* in heizer minne fiure (L.).

§ 10. One kind of separation is that which 'selects' one object out from a group. This meaning of 'aus' appears as early as the Middle High German period, tho it, like most of the specialized meanings developed by that particle, is still missing in Old High German. Frequently the verb by itself already contains the idea of selecting or choosing, which is intensified by the prefix.

Exodus (12th C.): niweht werkes solt ir tuon; iedoch gärwet iur ezzen, daz ir welt niezen, daz eine si iu *ouz genomen* mit mines selbes urloube (M.).

Lamprecht (12th C.): Sâlemôn der was *ûz getan* der sich ûzer allen kunegen nam ('that sich hervor', M.).[11]

Hartmann v. Aue (12th C.):

vrou Lûnet gap den eit,
und wart vil gar *ûz genomen*
daz im ze staten mohte komen
nâch dem sî dâr solde varn (Iwein 7909).

Wirnt v. Gravenberg (13th C.):

dô gap si im mit freuden da
drizec huobe ze eigen,
und hiez im *ûz zeigen*
daz beste hûs, als er si bat,
daz iender stuont in der stat (M.).

[11] The prefix distinctly adds an idea to this sentence, namely, that Salemon was placed outside the group of ordinary kings, and being extraordinary was synonymous with being superior.

Die Klage (13th C.): sie het wol *ûz gescheiden* Hagenen von in (M.).

Das alte Passional (13th C.): den keiser man dô *ûz las* und hiez in durch ein êre alsus mit zunamen Augustus (M.).

ein herre der vur die andern *ûz schôz* ('sich erhob', M.).

Monumenta Zollerana (13th C.): wir haben aus dem kouf *aus genumen* und aus gezogen alle guet (L.).

Hermann v. Fritzlar (14th C.): man sal gote volgen luterlichin durch got alleine, wanne man sal got lip haben umme sich selber alleine; unde was her nicht inist daz sal man *ûz slizen* (Deut. Myst. 1, 202, 31).

Stretlinger Chronik (15th C.): und schickt sin botschaft zu . . . dem herzogen von Burgunn, dass er einen vechtberen man wol gewapnet in sinem volk *ussůchte* (7, 22).

Düringische Chronik (15th C.): die fursten entphingen von om ir lehen, nôch deme alsô das zu rechte *uz gesetatzt* ['bestimmt'] ist (M.).

§ 11. There are different manners of separating one object from another or of removing part of an object from itself. Likewise the result may differ. It may cause the object to deteriorate, or it may enhance its value. When the primitive shipbuilder said: "Ich höhle den Baum aus," he was improving the state of the tree by removing out of it parts not needed. On the other hand, when we say: "Die Treppe is von dem vielen Gehen ausgetreten," we mean to say that it is worn and in consequence has deteriorated. The following list contains compounds to which the prefix has given the meaning 'to wear out'.

Günther (18th C.):

Die Weiber sind gar ausgelassen,
Sie thun es frei beim Mondenschein
So hitzig, dass auf manchen Gassen
Die Pflaster *ausgeritten* sein (DWb.).

Goethe (18th C.): Tief *ausgefahrne* Löcher, in die der Wagen umzustürzen droht (15, 34).

Die Backsteine des Fussbodens waren tief *ausgetreten* (23, 231).

§ 12. The following quotation from Gottfried von Strassburg shows the transition of meaning of 'aus' from 'to go out', 'to depart', to 'to end':

nâch der pfingest wochen
ze *ûz gêndem* meien (Trist. 15315).

The figure is that of May 'going out', that is, 'departing', which is identical with 'ending'. Whether Gottfried still felt the old figure or whether 'usgan' already meant 'zu Ende gehen', is impossible to determine from the material at hand. But since we have examples of compounds from contemporary writers in which the prefix unmistakably denotes that the action of the verb is completed, that is, ended, we may assume that the figure of the exit of May was already becoming dimmed for Gottfried.

Truhsæse v. St. Gallen (13th C.): Mîn wân ist noch niht *ûz gezelt* (Bartsch 30, 49).

Nicolaus v. Basel (14th C.): *ûz beten* = 'zu Ende beten' (L.).

Chroniken d. deut. Städte (14th C.): do die zwene mônôt *ûs kôment* (8, 293, 27).

Stretlinger Chronik (15th C.): do nû die mess *us was,* do trank er sant Johanns segen (143, 6).

A further step of this development is denoted by a sentence like: "Mein Geld reicht aus bis ich nach Hause komme." Home is a goal or end of the journey. Hence 'ausreichen' denotes that the money will last until the journey is ended. Further examples are:

Das alte Passional (13th C.): mit dem guote *ûz komen* und êre erjagen (DWb.).

Closener Strassburger Chronik (14th C.): dô fuoren si zu dem bôbste, daz sie ir sachen dô wolden *us tragen* (M.).[12]

§ 13. In the preceding section I have shown that transitive verbs compounded with 'us' may denote that the object has been brought to an end by means of the action indicated by the verbs. The result of the completed action may differ according to the meaning of the verbs. In the following group the completed action causes the object 'to become empty'.

Wirnt v. Gravenberg (13th C.): einen *ûz schütten* ('berauben', L.).

Nicolaus v. Jeroschin (14th C.): der zorn *ûz trinkit* minen geist (M.).

Keisersberg (15th C.): du *zerest* dich *aus* wie ein spinn, die nur mucken facht, und *spint* sich ganz *aus,* und im winter hanget sie dort und ist nichts dan ein läre haut (DWb.).

[12] This verb itself has a highly figurative meaning. The compound, however, is sufficiently transparent to admit of an analysis and thus enables us to determine the force of 'aus' = 'to a close', hence, 'to carry, to bring the affairs to a (successful) close'.

Pfarrer v. Kalenberg (15th C.):

dem volck dem was die weil zu lanck
den wein es allen *ausz* do *trank* (452).

§ 14. According to section 12 'us' gives to verbs with which it is compounded, a perfective meaning. If such verbs are transitive they denote that the action causes the object of the verb to come to an end, 'to be completed'; for example, "er hat die Geschichte auserzählt," means, 'er hat die Geschichte zu Ende erzählt'. Having finished it, the story is now complete or 'perfect'. The semantic development is similar to that of the English verb 'to finish', which, in modern English may mean 'to make perfect'. From designating a state of perfection attained by means of the act represented by the verb, the force of the prefix may be weakened to signify that the condition of the object is only 'improved'. Both these forces of 'us' are represented by the following quotations.

Heinrich v. d. Türlein (13th C.): man began im *ûz machen* sîn geziuge niuwe (L.).

Der j. Titurel (13th C.): [der Ritter], den sîn amie *ouz machet* liehter danne blüende heide (L.).

Keisersberg (15th C.): got hat das distelvögelin auf das allerschönst *ausgestrichen* mit hübschen farben (DWb.).

Luther (16th C.): Und da Salamo hatte *ausgebauet* des Herrn Haus (1 Kön. 9, 1).[13]

Opitz (17th C.): Die Natur hätte ihn nicht *ausgearbeitet,* sondern nur angefangen (DWb.).

Friedrich v. Logau (17th C.):

Wer nimmer nichts versucht, der weisz nicht was er kann,
Die Übung *würkt* uns *aus,* Versuch der führt uns an (DWb.).

Lessing (18th C.): Sie hatten von Natur schon Verstand genug, und im Kriege haben sie ihn nur mehr *ausgeschliffen* (DWb.).

Goethe (18th C.): Der rohe Mensch ist zufrieden, wenn er nur etwas vorgehen sieht, der gebildete will empfinden, und Nachdenken ist nur dem ganz *ausgebildeten* angenehm (Werke 18, 138).

Wenn Stein noch zu Haus ist, sagen Sie ihm, ich möchte gern das neue Pferdchen stallmeisterlich *ausreiten* (An Frau v. Stein 1, 98).

§ 15. When we do something until it is completed, we generally

[13] This clearly shows the close relationship between 'to finish building' and 'to make perfect by building'.

do it thoroly. As 'us' signifies the one thing, it may likewise come to mean the other, this being but a very short step removed. The point of contact between the two meanings is more apparent in some sentences than in others. The examples below do not contain sufficient material from an early period to justify definite conclusions concerning a point of departure.

Hermann v. Fritzlar (14th C.): aber di anderen brudere *swuren* sich *ûz,* daz si dar vone nicht inwisten (Deut. Myst. 1, 168, 17).

One is tempted to assume a rather forced figure of the brothers swearing themselves empty, that is to say, swearing until they are no longer able to swear more, which means in turn, to the full extent of their power.

Fastnachtspiele (15th C.):

si hant einander wüst *uszgriben*
sind doch by alten eeren bliben (896, 7).[14]

Hieronymus Braunschweig (15th C.): da einer mit rûten *ausgeschlagen* ist (DWb.).

The weakening of this meaning of 'aus' is shown in the following example from Goethe, who adds "wacker" to show the thoroness of the action:

Den (Polacken) *schlug* ich wacker *aus* dazumal (8, 25).

Hans Sachs (16th C.):

Auch hat die Jungfraw mich mit Zorn
Gehandelt, und mir *ausgeschorn*
Mit Worten so heftig und scharf (DWb.).

Friedrich v. Logau (17th C.):

Verleumdung, Neid und Hasz, Trug, Heuchelei und Höhnen,
Die *ausgeschmückten* Wort und fälschliches Beschönen,
Das hatte hier nicht statt (DWb.).

Günther (18th C.):

Hier *peitscht* die keusche Lust den abgewiesnen Jammer
Der alten Einsamkeit mit Myrtenreisern *aus* ('durch Peitschen bestrafen', S.).

§ 16. As shown in section 12, 'us' compounded with certain transitive verbs denoted that the object had terminated as a result of the action of the verb. The following examples belonging to that group are listed separately, because all of them contain figures based on one particular idea, namely that of extinguishing a light. Obviously this is nothing

[14] 'Einen beim Bad ausreiben' means 'gründlich trocken reiben'. Cf. Hildebrand, *Kleinere Schriften.*

more than putting a stop to its existence. There is only one example from Middle High German, and that is of a late date.

Nicolaus von Jeroschin (14th C.): daz lieht wart *ûz getân* (M.).

Sebastian Frank (16th C.): die Seel *ausblasen* (DWb.).

Lessing (18th C.): Auf einem zwischen inne stehenden Altare *auszudrücken* ('löschen', DWb.).

Göckingk (18th C.): Noch ist es Zeit dies Höllenfeur *auzzugiessen* ('auszulöschen', DWb.).

Jean Paul Richter (18th C.): Flamin habe dem Kammerherrn mit der Pistole das Lebenslicht *ausgeputzt* (DWb.).

Hellbemahlte Urne längst *ausgewischter* Tage (DWb.).

§ 17. In order to preserve our chronology it is necessary next to treat a development of 'us' to a meaning which seems to have nothing in common with those treated in the sections just preceding, namely, the prefix with the force 'to begin'. This is the opposite pole of 'to end', but the starting point of both is not so very far removed from either. The common source is 'us' with the secondary meaning 'to go forth from' (§ 6). If we consider this from the standpoint of 'departing' or 'going out', it is but a step to develop the meaning 'to end' (§ 12). If, on the other hand, the emphasis is laid on the 'issuing forth' or 'coming out', we are nearer the meaning 'to begin'. The 'beginning' is but a consequence of the 'issuing forth'.

Meister Eckhart (14th C.): si *sleht ûz* [fängt an] unde seit im alsô vil wunders (Deut. Myst. 2, 464, 6).

Lessing (18th C.): Da ich von dem Laokoon gleichsam *aussetzte* und mehrmals auf ihn zurückkomme ('ausging', DWb.).

Adelung (18th C.): sich *aussetzen* = acquit geben, beim Billiardspiel.

Der Gegner hat noch nicht *ausgestoszen*.

Campe (19th C.): *ausziehen* in Brettspielen = den ersten Zug thun.

Jeremias Gotthelf (19th C.): *austreten*, 'ausführen, ins Werk setzen' (S.).

§ 18. Thus far it has not been difficult to group the verbs compounded with 'us' into several well defined classes according to the meaning of the prefix. There are a number of compounds, however, whose prefixes have a force so general and varied in meaning, that it is impossible to fit them into classes. I have therefore not treated them in their chronological order, but will consider them now, before taking up

the semantic development of 'aus' during the New High German period. All of the meanings treated in preceding sections had their rise in Middle High German.

Since the prefix 'us' had assumed some very divergent meanings, it is not surprising that in some instances its force should become so dimmed that it adds nothing to the verb. This is the accompaniment of a paling of originally vivid figures of speech, or of the confusion of ideas, which could have taken place only after the original force of the particle ceased to be felt. Most of the compounds in this section have acquired a specialized meaning belonging to the technical terminology of various occupations, trades as well as sports.

Gottfried v. Strassburg (13th C.):

dâ kêrte er sîne reise hin.
dâ *stiesz* er *ûz,* dâ vand er in (Trist. 478).

Konrad Fleck (13th C.): dô er ze Nâpels *ûz stiesz* ('landete', M.).[15]

Arzneibuch (13th C.): den fuoz *ûz vallen* ('fallend ausrenken', L.).

Seifrid (14th C.): ein lampe diu was ein rubîn, diu was *ûz gedræjet* wol (L.).

Endres Tucher (15th C.): die rinnen mit holz *ausz futtern* (L.).

Aventius (16th C.): Die Curetes *wurfen* in selbst *aus,* daher sie Galli oder verschnittenen hieszen (DWb.).

Sebastian Frank (16th C.): Getulia ist ein Land das vil Elephanten *auszeucht* (DWb.).

Joh. Fischart (16th C.): Waaren *ausnehmen* ('sie auf Credit kaufen', S.).

Joh. Balth. Schuppius (17th C.): hatte unter dessen mein Land *ausgestellt* (DWb.).

Dietrich v. dem Werder (17th C.):

man kan bald weichen sie, bald für sich schreiten sehen,
bald *nehmen* sie Streich *aus,* bald lassen sie sie gehen (DWb.).

§ 19. One of the important things to be noticed regarding the particle 'aus' is its deterioration to a rudimentary condition. In a number of compounds the prefix 'aus' scarcely adds anything to the meaning of the simple verb, frequently nothing at all. In some cases, such as 'ausdeuten', the prefix may have been added by analogy to some other word, for instance, 'auslegen'. In the former word the prefix is purely tautological, while in other words it may have the force of intensifying the

[15] Probably this is the result of fusing two ideas, namely, "da stiess er zu Neapel ans Land und stieg aus."

verb. Altho the prefix thus weakened occurs frequently since Luther's time, it is not represented by examples from an earlier period.

Luther (16th C.): Da sie hofften, *halfes* du ihnen *aus* (Psalm 22, 5).[16]

Weist du, wie sich die Wolken *ausstreuen?* (Hiob. 37, 16.)

Haben sie den Gast mit Dreck wöllen *auswerfen* (DWb.).

Ich will mein Netz über dich *auswerfen* (Hes. 32, 3).

Hans Sachs (16th C.):

Ei'm Buhler oft ein Glück zufällt
Dasz ihn ein schöne Frau *aushält* (S.).

Die Stiefel *ausputzen* ('putzen', S.).

Rechnets nicht zu den Ergsten *aus* (DWb.).

Opitz (17th C.):

Das sind der Jugend Sitten
Sie *schlägt* grimmig *aus,* und kan ihr nicht gebieten (DWb.).

Joh. Balth. Schuppius (17th C.): *Deuten* ihm fast alle seine Wort anders *aus* als seine Meinung war (DWb.).

Jucundi Jucundissimi wunderliche Lebensbeschreibung (17th C.): Wie wunderlich uns die stiglfritzischen Spitzbuben mit dem Lustwasser *ausgezahlet* hatten (DWb.).

§ 20. The examples in this section are of verbal compounds with 'aus' which are obviously literal translations from a foreign language. There are many such thought translations in the language, as far back as the Gothic. In fact, wherever a translator finds himself confronted with an idea foreign to his mother tongue, there are but two ways out of the difficulty: either he must borrow the foreign expression, or fit a native term to the foreign idea. The innumerable loan words are examples of the former procedure, while 'Gewissen' < 'conscientia' and the German names for the days of the week are examples of 'thought transference'.

A collection of all such words with the history of their introduction, would be a work well worth doing. It may be assumed, that the expression existing in the language at the time the word was introduced, did not satisfy the author forming such a word. Whether an equivalent may in reality not have existed or whether the author may have preferred a new word, or rather an old one with a new signification, would

[16] This is probably an elliptic sentence which originally contained an object for 'aus', for example, "aus der Not."

have to be determined. Such an investigation could not help throwing some light on the cultural condition of the period during which these words were coined. Considerable care must be taken to avoid including in this class, words which express ideas common to all peoples.

Adelung (18th C.):

"sich *ausreden* = sich durch Worte von einer Schuld oder Verbindlichkeit zu befreyen suchen, sich entschuldigen. Sich mit etwas ausreden. In dieser Bedeutung ist 'ausreden' nach dem Latein 'excusare' gebildet, in welchem man das im Hochdeutschen veraltete kösen, kosen, und kusen ('reden'), nicht verkennen kann" (Wörterbuch).

Tieck (19th C.): Ich habe nur *ausgezogen* [aus einem Buche] (DWb.).

Campe (19th C.): ein *ausgebissenes* Blatt (Folium erosum < ex rodo), in der Pflanzenlehre, dessen Rand ungleich ausgeschnitten ist, als wenn es benagt wäre.

PART III.

'HERAUS' AND 'HINAUS' WITH THEIR ORIGINAL FORCE

§ 21. As seen at the beginning of this chapter (§ 1), the adverbial particle 'us' in Old High German and Middle High German sufficed to express the idea now generally requiring 'her' or 'hin'. The two Middle High German examples below, one from Hartmann, the other from Gottfried, show clearly the demonstrative force of 'hin' as it was originally felt. In both examples 'us' has retained its original force, 'out of', and 'hin' expresses the old idea, 'away from the speaker'.

Hartmann v. Aue (12th C.):

mit grôzen kreften *stach* er in
enbor *ûz* dem satel *hin* (Iwein 4671).

Gottfried v. Strassburg (13th C.):

und *tâtens* alle mit gewalt
ûz hin ze velde vür den walt (Trist. 5478).

§ 22. In considering the next list of quotations, we can trace the gradual creeping in of the old demonstrative particle, beginning in the Old High German period, during which there is but one example each for 'herauz' and 'hinauz'. Both of these are from Otfried's Gospel Harmonies. That the original idea of direction contained in the adverb

could still be expressed by the adverbial particle unaided by 'her' or 'hin' is evident from a parallel passage from the translation of Tatian, where we find: "sênu ih *leitu* inan iu *ûz*" (197, 2). Otfried renders this passage: "*herauz,* quad, *leitu* ih inan iu" (4, 23, 3). The latter is more nearly like Luther's translation: "Ich *führe* ihn *heraus* zu euch" (Joh. 19, 4). Cf. the Latin: "adduco vobis eum foras."

Altho Otfried's work antedates the Old High German translation of Tatian by a few years, we may call the authors of the two works contemporaries. Thus we see, that at this time 'uz' and 'herauz' had nearly the same force. This is what we should expect at the time when a new expression is just beginning to supplant an old one. For a while both would be used synonymously, until gradually one or the other asserts itself. It would not be safe to draw conclusions as to the relative merits of the two old monks concerning their German "Sprachgefühl," for neither is especially independent of his Latin source.

Graff failed to record any verbs compounded with 'heruz' or 'hinuz' from Old High German. During the Middle High German period (12th to 15th centuries inclusive), there is, however, a noticeable increase in the number of verbs with the double prefix, tho even at the end of that period the number is still small, only twenty verbs having been added during those four centuries. In all of these the prefixes have a distinctly demonstrative force, and no doubt they were intended to express a little more than the simple particle could have done. It should not surprise us that of these twenty verbs, six were used by Wolfram von Eschenbach, for as we follow the spread of the double prefixes, we shall notice that those writers who possessed the deepest feeling for the subtleties of the language, and who had the courage to introduce new forms to distinguish fine shades of meaning, were also the men who were most free in their use of the double prefix.

The following comparatively complete list of quotations containing verbs compounded with 'herus' and 'hinus' shows the very small number of compounds thus formed prior to the New High German period. Only the first appearance of any verb with the double prefixes 'herus' or 'hinus' is listed.

Otfried (9th C.): *Herauz,* quad, *leitu* ih inan iu (4, 23, 3).
uuerfet, quad er, thiz *hinauz!* (2, 11, 21.)

Hartmann v. Aue (12th C.):

er *gienc hin ûz* zuo in zehant
da er sî ensamt sitzen vant (Iwein 883).
dô was diu juncvrouwe *genomen*
herûz dâ sî gevangen lac (Iwein 5149).

Wolfram v. Eschenbach (13th C.):

dar zuo der zinnen ieslich
mit armbruste ein schütze pflac,
der sich schieszens *her ûz bewac* (Parz. 351, 30).
die [zwei Ritter] wârn *hin ûz gevangen,*
und *kômn her în* gegangen (Parz. 85, 7).
als gein einem æhtære
schupfterz volc *hin ûz* an in (Parz. 284, 9).
du *wære hin ûz* ûf den plan (Parz. 118, 20).
nu het ouch sich vil gar verholn
Parzivâl *her ûz verstoln* (Parz. 703, 22).
sus *zôch* mîn hêr Gâwân
daz ors *hin ûz* ûf den plân (Parz. 603, 16).

Thomasin v. Circlaria (13th C.): *her uz schütten* (DWb.).

Gedichte des 12ten und 13ten Jh.: hieszen den bachoven so vaste heizen daz daz fiwer *her uz sluoc* (Hahn, M.).

Das alte Passional (13th C.): selmesse und gebet hât er vil *her us gesniten* ('befreit', M.).

Meister Eckhart (14th C.): daz von ûzen în wirt gesprochen, daz ist ein grob dinc: ez ist în gesprochen, *sprich* ez *her ûz!* daz ist: bevint daz diz in dir ist (Deut. Myst. 2, 207, 25).

Konrad v. Megenberg (14th C.): so reibt sich das tier an ainem paum unz daz apostêm zerpricht und der unflât *her auz fleuzt* (DWb.).

her ûz, her für *sliefen* (M.).

Ulrich Boner (14th C.):

ûz dem walde *kam* er *har ûz*
gegangen vür ein einig hûz (DWb.).

Clara Hätzlerin (15th C.): wir *gangen* spazieren *hin ûz* (M.).

Germania: do wart die kaiserinn eines sunes swanger ze Rom in der stadt. Dar nach *fuer* der kaiser und die kaiserinne *herauz* gein tautschen lanten (DWb.).

Stretlinger Chronik (15th C.): Und als man in *hinûs fůrt* zů erhenken (119, 25).

do ir nů also das versechen was, dass si nit *hinus* mocht *kommen* (86, 2).

. . . dass er die tür, da si *hinus möcht* oder wölt gan (85, 27).

§ 23. The following table, compiled chiefly from dictionaries, shows the number of verbal compounds added during various periods. The figures for the 16th and 18th centuries are exclusive of Luther and

Goethe, both of whom are listed separately. Numbers in parentheses are those of verbs also recorded from writers subsequent to Campe.

	'HERAUS'	'HINAUS'	TOTAL
Old High German period	1	1	2
Middle High German period	11	9	20
Luther	31	15	46
Rest of 16th Century	8	—	8
17th Century	28	18	46
Goethe	22	17	39
Rest of 18th Century	66	21	87
Campe	37 (14)	61 (23)	98
19th Century	25	21	46
	229	163	392

§ 24. From the above statistics the great increase of verbs with the double prefixes since the end of the Middle High German period is readily seen. Luther alone with 46 verbs represents an increase of 65 per cent. It is evident from the weakening of the form 'heraus' to 'eraus', and even 'raus', which is found in early 16th century writers, that the double particle must have been in use for some time prior to this. The 18th century has produced the greatest number of new formations. As it was Wolfram in the 13th century and Luther in the 16th century, so in the 18th century it is the man with the deepest grasp of the spirit of the German language, who is freest in the use of the double compound, that is, Goethe. Klinger follows with 9, Wieland and Lessing with 8 and 6 respectively.

The most prolific contributor for the period was J. H. Campe in his dictionary. Tho this did not appear until 1807+, we may justly call it a product of the 18th century. The numbers in parentheses in the preceding section show that only a little over 35 per cent of the words first recorded by Campe have been accepted by subsequent writers. Campe does not cite an authority for any of these words, merely listing them. He had a weakness for new words, especially those of his own coinage. Most of those here considered are based on analogy, and all of them are possible compounds. In several instances Campe had a precedent for either a compound with 'heraus' or one with 'hinaus', so that he introduced but one or the other of the parallel forms. In many instances, however, his compound is a new coinage pure and simple.

§ 25. It has been shown that the addition of 'her' or 'hin' to the adverbial prefix restored to the latter its original force, that is, 'out of',

'outward from within', which original force the adverbial particle had come to sacrifice as part of a compound. It is to be expected that the new double prefix 'heraus' or 'hinaus' should also lose its original demonstrative meaning. Such deterioration is taking place. But many of the compounds are of such recent formation that they have not yet been blended into a group meaning. Then also, 'her' and 'hin' still exist as living words with an independent existence, which aids them in retaining their full force in the folk-consciousness even in compounds.

PART IV.

NEW MEANINGS ACQUIRED BY 'HERAUS' AND 'HINAUS'

§ 26. The functional weakening of the double prefix begins during the Middle High German period, but examples of it are rare. A passage from Hermann von Fritzlar (14th C.), shows beyond doubt that for him 'heruz', in this one instance at least, no longer constituted a prefix composed of a demonstrative and an adverbial particle whose combined force was equal to 'out of' and 'toward the speaker'. The sentence referred to is: dô daz tir geloufen quam in daz hol und leite sich vor sîne fuze, dô *ginc* der heilige man ***her ûz her*** und warte wer daz tir gejagete hete (Deut. Myst. 1, 193, 35). The additional 'her' after 'heruz' is strong evidence that the prefix was not strong enough to satisfy the author, hence an extra adverb to signify motion in a certain direction. Yet, in spite of the heaping of almost identical words, Hermann does not succeed in stating what he intended. 'Her' originally pointed out that the motion of the verb it modified was toward the speaker. Later, however, it became more general in its application, frequently referring to an approach to something outside the speaker. But in the above sentence it is impossible logically to conceive a point of approach for the verb 'ginc'. The author confuses 'her' and 'hin', a mistake rather common in modern German. (Cf. § 28.)

§ 27. As the force of 'her' and 'hin' was no longer clearly distinguished, this necessarily led to a dimming of the meaning of both prefixes. Which of the two was first to sacrifice its old force, and which to assume a specialized meaning, is impossible to determine. It is even impossible to say that one prefix developed one set of meanings, while the other developed in another given direction. In fact, they often coincide.

§ 28. It is interesting to note that it is the double prefix 'heraus' which is most subject to functional decay, so that it no longer denotes a motion toward the speaker. It is frequently difficult to determine just what the position of the speaker would be.

Luther (16th C.): Da *fuhren* die Kinder Benjamin *heraus,* dem Volke entgegen (Richt. 20, 31).

Adam Olearius (17th C.): Wer sich wider den Feind nicht *heraus lässet,* wird ihn nicht überwinden (DWb.).

Goethe (18th C.): Aber warum *gehe* ich auch aus meinem Charakter *heraus!* (17, 106.)[17]

Bürger (18th C.): Den 'Hund' muss ich aus der Übersetzung *heraus lassen,* denn sonst schimpfte Achill wie ein deutscher Oberst (DWb.).[18]

F. Nicolai (18th C.): Ob ich gleich . . . mich vollkommen überzeugt habe, dass alles auf ein leeres Spiel mit Begriffen *herausgeht* (DWb.).

J. J. Engel (18th C.): sich selbst aus der guten Laune *heraus setzen* (S.).

Eichendorff (19th C.): (Ich sass im Wagen und) *lehnte* mich auf beide Arme zum Wagenfenster *heraus* . . . (Taugenichts).

Gutzkow (19th C.): Sie erzählte, wie sie . . . ihr Dasein, ihre Jugend, ihr Glück, rein an Nichts *herauswürfe* (S.).

Müller-Guttenbrunn (20th C.): Endlich ist es mir gelungen, sie *herauszutreiben* aus ihrer kühlen Reserve (Glocken 225).

§ 29. The confusion of ideas contained in 'heraus' and 'hinaus' resulted in the loss of the original force of the prefix and permitted it to acquire specialized meanings otherwise impossible. One of the first meanings developed by the simple prefix 'aus' was that signifying a 'departure from a source' (§ 6). In the oldest New High German records 'heraus' also has acquired this force.

Luther (16th C.): Denn ich schepfe meine Liebe nicht aus deiner Frömmkeit . . . das heisst, liebe deinen nehesten, da *geht* sie reichlich *heraus* (DWb.).

Und soll von dannen *heraus gehen* Lob- und Freudengesang (Jer. 30, 19).

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[17] 'Heraus' is justified if Goethe looks upon his character objectively.

[18] The use of the intensive form is characteristic of Bürger. Cf. the author's article, *Bürger als Bereicherer der deutschen Sprache,* in *Zeitschrift für deutsche Wortforschung,* 14, 225-279.

In both of the above quotations 'hervor' could be substituted for 'heraus' without changing the meaning of the sentence.

§ 30. Under the same head is to be classed the meaning 'to make an appearance', especially with reference to the publication of a book and the like. Altho various verbs are used to express the idea of publishing, the prefix 'heraus' is common to all of them.

Schuppius (17th C.): Es hat . . . Herr Joh. Mich. Dillherr von dieser Materi, . . . nemlich von der heiligen Sontagsfeier, ein schönes, geistreiches, nützliches Büchlein ***herausz gehen*** lassen (DWb.).

Ich will underschiedene theologische Tractätlein ***heraus kommen*** lassen (DWb.).

Dasz einer . . . ein . . . Pasquil wider mich habe ***herausz gelassen*** (DWb.).

§ 31. Another meaning of 'heraus' occurring as early as the writings of Luther, is that of 'coming or taking out of a group', and rising or raising above the rest of its kind, that is, 'to take on' or 'give prominence to'.

Luther (16th C.): Das innerliche Wesen muss sich nicht viel ***heraus brechen*** (DWb.).

Opitz (17th C.):

Wie sehr [eine Frau] an Ehrbarkeit und Tugend
Für aller ihrer Jugend ***herauszgeschienen*** hat (DWb.).

Goethe (18th C.): Er wusste meine geselligen Talente ***herauszzusetzen*** (25, 143).

Theo. Gottl. Hippel (18th C.): Er erhob seine Stimme, und diese ***nahm*** sich so ***heraus***, dass jeder aufmerkte (DWb.).

Jean Paul Richter (18th C.): Hof konnt ich ohne Schaden ***herausnennen*** (DWb.).

Campe (19th C.): So sehr man auch die Weisheit unsers Jahrhunderts ***herauspreiset***.

§ 32. While in the preceding three sections 'heraus' was shown to have followed a development similar to that of 'aus', the following two sections contain meanings of 'hinaus' almost identical with those of the simple prefix. As early as the beginning of the 12th century 'aus' had given to the verb the idea of perfected action. By the time of Luther, 'hinaus' had acquired the same force. Intransitive verbs show that the subject has terminated. The transitive verbs in this section denote that the objects are completed or finished by means of the action of the verb.

INTRANSITIVE VERBS

Luther (16th C.): Es wird gewisslich so ***hinausgehen,*** wie der Psalm sagt (DWb.).

Gesegnet seist du . . . du wirst es thun und ***hinaus führen*** (1 Sam. 26, 25).

Adam Olearius (17th C.): Da siehet man, dass oft eines weisen Mannes Rath nicht nach seiner Meinung ***hinaus schläget*** (DWb.).

. . . ein Zank, so endlich auf eine Schlägerei ***hinaus lief*** (DWb.).

Goethe (18th C.): Es ***kommt*** auf Eins ***hinaus,*** wir sind aus unserm Kreise gedrückt (Götz 8, 134).

J. H. Voss (18th C.): Möge . . . dir ***hinausgehn*** was du verlangst (S.).

TRANSITIVE VERBS

Luther (16th C.): Wiewol ich nu zu gering bin, Stück fürzulegen zu solchs grewlichs Wesens Besserung dienlich, wil ich doch das Narnspiel ***hinaus singen,*** und sagen so viel mein Verstand vermag was wol geschehen möcht und solte (DWb.).

. . . und sollen und wollen . . . das Spiel also hinaus machen (DWb.).

Agricola (16th C.): Allein ***bringestu*** dein Ding und Tyrannei mit Gewalt ***hinauss,*** und trittest alle Gesatz mit Füssen, so mûsz es recht sein und heissen (DWb.).

Schuppius (17th C.): Du (Gott) hast meine Sachen besser als ich gedacht, ***hinaus geführt*** (DWb).

Goethe (18th C.): Keiner von uns hatte das Buch ***hinausgelesen,*** denn wir fanden uns in der Erwartung getaüscht (26, 69).

Herder (18th C.): Resultate eines über die Hälfte ***hinausgelebten*** thätigen Lebens (S.).

Klinger (18th C.): Ich darf den Gedanken nicht ***hinausdenken*** (DWb.).

§ 33. Since it is the verbal compound with 'hinaus' which most frequently indicates the completion of an activity, we should expect the same prefix to be used with verbs referring to the act of 'drinking to an end'. But instead, 'heraus' is prefixed to certain verbs to denote that their objects have been emptied by means of the action indicated by the verbs, that is to say, all of the contents have been removed, the removing is complete. Psychologically this 'her' can be explained by the fact that

originally the subject of the sentence, that is, the point of approach, was the speaker.

Johann Pühler v. Schwandorf (16th C.):

Ich setzt das Gläslein an den Mund,
Trinks heraus bis an den Grund (DWb.).

Later this use was extended to a subject in the third person.

Joh. Peter Hebel (18th C.): Der Hausfreund hat schon manch Schöpplein mit ihm *heraus gemacht* (S).

§ 34. In one group of durative verbs the prefix 'hinaus' emphasizes the 'duration of the action'. In intransitive verbs the action refers to the subject as extending or reaching out, while it is the object which is extended in the case of transitive verbs.

Luther (16th C.): (Die Grenze) . . . zieht sich von mitternachtwärts, und *kommt hinaus* gegen En Semes, und kommt hinaus zu den Haufen, die gegen Adumin hin auf liegen (Jos. 18, 17).

Grimmelshausen (17th C.): Damit (mit dem Gelde) *reichte* Julus nit weit *hinaus* (DWb.).

Butschky (17th C.): Also geschihet es auch unter geringeren Leuten, das sie einem bösen Rat folgen, der mehrmals über den, der ihn gibet *hinaus gehet* (DWb.).

Das Register [seiner Frevel] würde allzuweit *hinaus laufen* (DWb.).

Joh. Gottw. Müller (18th C.): Wir würden unser Buch in eine unendliche Länge *hinausspinnen* (DWb.).

Jean Paul Richter (18th C.): Viele Werke sollen ihrer Natur nach, wie Kalender, nicht ins Blaue *hinaus leben* (Wke. 1, 126).

The following quotations are examples of the same force of the prefix in a temporal sense.

Grimmelshausen (17th C.): Er hatte . . . viel zu wenig [Geld] seinen verschwenderischen Pracht *hinaus zu führen* (DWb.).

Stieler (17th C.): Die Zeit weit *hinausschieben* (DWb.).

Lessing (18th C.): Wann nur . . . der Ausgang der Entscheidung sich nicht ins Lange *hinausziehet!* (DWb.).

Jean Paul Richter (18th C.): Meinem Glück fehlte nichts, als dass gar der heutige Sektor glücklich geschrieben war, den ich bis heute *hinausspielte* (DWb.).

§ 35. Another instance in which the double prefix 'heraus' has usurped the meaning formerly possessed by 'aus', is that referring to the

voice as 'issuing forth', that is, 'coming out of someone'. The figure of the voice coming out of the mouth was employed very early, and was expressed by the particle 'aus' prefixed to an appropriate verb, for example: O. H. G., 'uzlazan', M. H. G., 'sich uztuon', uzschrien', etc. As time went by the figure was retained, but the function of the particle weakened. Hence, as in other cases, 'heraus' was substituted for 'aus'.

Adrian (17th C.): . . . *da schrei* herausz das tartarisch Gesind, sie wolten sich ergeben geschwind (DWb.).

Grimmelshausen (17th C.): Dass es redlicher und feiner sei, mit der Wahrheit *herauszugehen* (DWb.).

Christ. Weise (17th C.): Die sich so kühn und offenherzig nicht dürfen *heraus lassen* (DWb.).

Goethe (18th C.): Sie *wollte* mit der Sprache nicht *heraus* (21, 219, S.).

Wieland (18th C.): (Er) *zieht* aus tiefer Brust den längsten Seufzer *heraus* (S.).

Schiller (18th C.):

Er *ruft* den Zorn des Schwerbeleidigten,
Der Fürsten alte Schwüre jetzt *heraus* (DWb.).

J. H. Voss (18th C.):

Hat Leiden dir das Blut vergällt,
Und wühlt dir Groll im Herzen,
Ihn lieber grad *herausgebellt,*
Als unter bittern Scherzen! (DWb.)

Christ. Fel. Weisze (18th C.): Ich muss doch ein bischen hören, was sie *herausgeben* (DWb.).

The next quotation is the only example of 'hinaus' in connection with this idea. 'Hin' indicates a subtle difference between this and the preceding sentences. In the latter, the perceiving of the voice by the speaker is of most importance, while in the sentence from Tieck, emphasis is laid on the fact that the utterance, in this case a hymn, is sent forth by some one.

Tieck (19th C.): Meinen Sie denn hier einen Montblanc etwa zu allererst erklettert zu haben, um in so unziemlichen Hymnen *hinaus zu brechen* (DWb.).

§ 36. The combination 'auf . . . hinaus' may be looked upon as one compound, since the group contains but one thought. 'Auf' points out the goal. Its force is similar to 'auf' in the combination 'auf . . . zu' = 'toward'. 'Hinaus' has retained its old force, but is used figuratively.

Friedrich v. Logau (17th C.): Der Adelstand der liegt, ein jeder *geht drauf naus* (DWb.).

F. Nicolai (18th C.): [Ich habe mich] überzeugt, dass alles ***auf*** ein leeres Spiel mit Begriffen ***herausgeht*** (DWb.).

Referring to this and the following quotation, DWb. says: "Verwechselung von 'heraus' mit 'hinaus' ist eingetreten."

Kant (18th C.): . . . dass alle diese Arbeit ***auf*** nichts ***herauslaufe*** (DWb.).[19]

Jean Paul Richter (18th C.): Gleichwohl seh ich noch kein einziges Schreiben gedruckt; man ***setzt*** die Publication, scheint es, ***auf*** mein Verscheiden ***hinaus*** (DWb.).

Frenssen (19th C.): Dann wird er ihn zum Konkurs treiben, ***worauf*** sein ganzer Plan seit Jahren ***hinausläuft*** (Sandgräfin 138).

§ 37. A similar combination is 'über . . . hinaus'. In this group the original figure is clear. It was a concrete conception of an enclosed space surrounded by a wall or hedge. The prefix 'hinaus' retained its original force. In order to get out of the enclosure it was necessary first to get over the wall. Hence, 'to get out', implies a little something more than 'to get over'. It denotes that the action has progressed to a point beyond the wall. In course of time this combination acquired the specialized meaning 'beyond'. And as 'über' frequently refers to an object as being over and above another in quality, the idea 'beyond' developed into 'superior to'.

The following list contains examples of the combination 'über . . . hinaus . . . verb', in which the old concrete force of each of the units of the compound is preserved.

Steinbach (18th C.): Das Lager ein wenig ***über*** einen Ort ***hinausrücken*** (DWb.).

Schiller (18th C.): ***Rückte*** sie die Grenzen ihres Gebietes ***über*** das Weltmeer ***hinaus*** (S.).

Müller-Guttenbrunn (20th C.): Er [Danubius] schwang seinen Dreizack und stiess sie [die Eismengen] zurück, staute sie zu Bergen auf und ***warf*** sie ebenfalls ***über*** den Damm ***hinaus*** (Glocken 251).

Quotations with the force 'beyond' in a figurative sense follow.

Goethe (18th C.): Doch als dieser schwieg und einer traurigen Erinnerung auszuweichen schien, hielt Eduard gleichfalls an, so wie auch Charlotte . . . ***über*** jene Äusserung ***hinausging*** (17, 44).

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[19] In these two quotations, the force of 'hinaus' borders on that discussed in § 32, namely, 'to terminate an act'.

Doch indem ich schon fürchten muss, *über* die Zeit *hinausgegriffen* zu haben, von der hier die Rede sein kann, kehre ich . . . (26, 199).

Woraus wenigstens hervorzugehen schien, dass man *über* die Unarten und Unschicklichkeiten jenes berufenen Mannes noch allenfalls *hinauskommen* werde (31, 235).

Ob sie gleich viel jünger ist als ich, so hatte doch die Gegenwart der ältern Freundin so viele Reize für dich, dass du *über* die aufblühende versprechende Schönheit *hinaussahst* (17, 20).

Ich verwünsche dabei die Matthissons, . . . die uns schwerfällige Deutsche sogar in Liedern *über* die Welt *hinausweist* (DWb.).

Wieland (18th C.): Aristipp, dem alles übertriebene, angemasste und *über* die Proportionen der menschenlichen Natur *Hinausschwellende* lächerlich oder widrig ist (S.).

Kant (18th C.): Dass wir vermittelst des Begriffes der Endursachen *über* die Natur *hinauslangen,* und sie an den höchsten Punct in der Reihe der Ursachen knüpfen (DWb.).

Jahn (19th C.): Gräber *leben über* längst begrabene Völker *hinaus* (S.).

Börne (19th C.): Ein morscher Selbstling, dessen Geist nicht *über* den Augenblick *hinausragt* (S.).

Devrient (19th C.): Er hat es damit *über* hundert *hinausgebracht* (S.).

The last step of this development is shown in the following sentences. They denote that something rises or is elevated above the object of the preposition, figuratively speaking. This is identical to saying it is superior to that object.

Goethe (18th C.): Dreimal glücklich sind diejenigen zu preisen, die ihre Geburt sogleich *über* die untern Stufen der Menschheit *hinaushebt* (18, 247).

Wie viel Stücke haben wir denn, die nicht *über* das Mass des Personals . . . *hinausschritten?* (19, 159.)

Mich freut immer, wenn einzelne Personen fühlen, *über* was man sich *hinaussetzen* kann und soll (19, 7).

Schiller (18th C.):

So schreiten keine irdischen Weiber
Die zeugete kein sterblich Haus!
Es *steigt* das Riesenmass der Leiber
Hoch *über* menschliches *hinaus* (DWb.).

Ich fühle den Adel meines Bluts, kann es nicht dulden, dass dieses Haus Doria *über* unsre Ahnen *hinauswachsen* will (Fiesko 1, 1).

Jean Paul Richter (18th C.): . . . weil an Höfen und Klavieren keine Taste *über* die andere *hinausklingen* darf (DWb.).

Ich werde mich *über* die Menschen *hinausreissen* (DWb.).

SUMMARY

§ 38. Summarizing briefly, the following points have been brought out in this chapter:

1). Originally 'aus' was an adverb of direction denoting 'out from within certain limits'. At the time of the earliest records of the Germanic languages it was already compounded with verbs, retaining its old function of denoting a motion out from somewhere, but it could be compounded with verbs of motion only.

2). But very early records show a weakening on the part of the prefix.

3). It was shown that the prefix acquired many different meanings, all growing out of its old force (§ 4 ff.). This tended further to reduce its scope of application in the original sense.

4). The result was that it gradually lost its old function of denoting a motion out from an enclosure.

5). Hence some other element was required to assume the function surrendered by 'aus'. For this purpose 'her' or 'hin', forms of an old demonstrative pronoun, were prefixed to 'aus' to denote respectively, a motion toward or away from a speaker.

6). Nearly all of the specialized meanings assumed by 'aus' were developed during the Middle High German period.

7). The double prefixes 'heraus' and 'hinaus', one example of each being found in Old High German, appeared only as isolated neologisms during the greater part of the Middle High German period. By the time of Luther, however, they had established themselves in the language and were employed commonly to indicate the idea formerly expressed by the simple prefix 'aus'. Many new compounds with 'heraus' and 'hinaus' have been introduced by subsequent centuries.

8). Finally, I have shown that the double prefixes which were introduced to replace the old weakened simple prefix, have themselves acquired specialized meanings, and are showing functional decay, tho not yet to such an extent as to require another substitute to denote their original force.

CHAPTER II.
EIN, HEREIN, HINEIN

PART I.
'EIN' WITH ITS ORIGINAL FORCE

§ 39. In section 1 'aus' was shown originally to have been an adverb denoting motion 'out of a place'. Motion in an opposite direction was shown by the adverb 'ein' (< in). For the adverb of rest the form 'inne' was used. There are a few instances, however, in which the prefix 'ein' does not denote motion. These can be accounted for:

1). Because of a confusion and consequent blending of the two forms 'ein' and 'inne'.

2). Because of the fact that originally the idea of motion may have been present.

The latter development is well exemplified by a passage from Gottfried von Strassburg's "Tristan und Isolde":

Der getriuwe marschalc Fointenant
fuor heim und sprach sîn sælic wîp
und bevalch ir verre und an den lîp,
daz sî sich *în leite*
nâch der gewohnheite,
als ein wîp kindes *inne lît* (1895).

It is readily conceivable that 'sich în legen' should influence 'inne ligen' to become 'inligen', which accounts for modern German 'einliegen'. To a similar development may be due the phrase, 'der einliegende Brief' < "der Brief, den ich einlegte." Such blending of ideas is not at all contrary to the psychology of language. In 'einhaben' we probably have an elliptic sentence to deal with, in which the verb of motion was omitted and eventually lost sight of entirely.

Pontus (15th C.): Die gar ein grosses feld *einhetten* (DWb.).[20]

Joh. Fischart (16th C.): Schleuzt sie zwischen zwo Mauern und läszt sie alda so lang leben als sie können, gleichwie man zu Altdorf, . . . hat sehen mögen, das etlich acht oder zehen, etlich zwanzig und dreiszig Jar lang *eingelegen* waren (DWb.).

[20] Modern German would substitute 'innehaben' for 'einhaben'.

While the prefix 'aus' has developed various widely divergent meanings, in some of which there is no longer any trace of the original force of the adverb, the particle 'ein' has preserved its old force in nearly every case where it is compounded with a verb, even when the verb has greatly changed its meaning, and the compound as a whole become highly specialized.

§ 40. It will be necessary to deviate slightly from the plan followed in Part I of the preceding chapter, because the development of 'ein' differs somewhat from that of 'aus'. It is possible to give a large number of examples of verbs compounded with 'aus' from the older language for which we should now substitute 'heraus' or 'hinaus'. The number of verbs formerly compounded with 'ein' but now requiring 'herein' or 'hinein' is much smaller. Altho 'ein' meaning 'into' is no longer common as an active prefix to verbs of motion, its old function is still so strongly felt, that the addition of 'her' or 'hin' has not been deemed so necessary as in the case of 'aus'. In general, it may be said that 'aus' as a prefix has rarely a force in modern German identical with 'heraus' or 'hinaus', while on the other hand, there are innumerable compounds with 'ein' which have a form with 'herein' or 'hinein' almost synonymous.

§ 41. In the following quotations the prefix 'ein' is used with its original meaning, 'into'. Altho the objects into which an entrance is made are omitted in the quotations in this section, they may readily be supplied from the context.

Otfried (9th C.): giang aftar imo . . . thô er inan sah thara ***ingân*** (5, 6, 28).

Tatian (9th C.): inti quad theru duriuuartun inti ***inleita*** Pêtrusan (186, 3). Cf. Joh. 18, 16: führte Petrus hinein.

suohtun inan ***in zi traganne*** (54, 2).

Keronisches Glossar (11th C.): ***în werphan*** (= 'hereinwerfen', Graff).

Heinrich v. Melk (12th C.):

si sint als ein durcheler sac,
vil wol ich siu alsô haizzen mac—,
dâ man oben ***în schiubet,***
und niden ûzstiubet, (Priesterleben 744, L.).

Heinrich v. Veldeke (12th C.):

die salmen er ***în truhte***
sam daz fuoter tuot daz vihe (M.).

Walther v. d. Vogelweide (12th C.):

so hân ich ouch im vil nâhen
in mîme herzen eine stat gegeben,
dâ noch nieman *in getrat* (DWb.).

Hartmann v. Aue (12th C.): dâ *reit* der wirt vor im *in* (Iwein 1095).

Wolfram v. Eschenbach (13th C.):

er bat den gast, den er dâ sach
în füern, und schaffen sîn gemach (Parz. 163, 14).[21]
dar nâch gebôt er im dô sân
daz er *kêrte* nâch im *în* (Parz. 42, 5).
der vilân *trat* wider *în* (Parz. 570, 25).
der marcgrâve zer künegîn
sprach 'süeziu Gyburc, *lâ* mich *în*' (Willehalm 90, 2).
sîniu kinder *liefen* vor im *în* (Parz. 23, 18).
dane wâren si [die Anker] ninder *în geslagen* (Parz. 15, 1).
[die Näpfe] die *truagen* junchêrren *în* (Parz. 84, 23).

Gottfried v. Strassburg (13th C.):

hie mite *sante* ouch der künic *în*
einen boten nâch der künigîn (Trist. 10880).
aldâ *gezôch* sich Tristan *în* [in daz kastel] (Trist. 18773).

Meister Eckhart (14th C.): Got ist bî allen den, die in lockend und in *în nement* und in *în sprechent* (Deut. Myst. 2, 102, 30).

Hermann v. Fritzlar (14th C.): do wisete in der oberste priester abe und wolde nicht sîn opfer, wan iz was alsô geboten, daz di nicht vrucht *inbrâchten* di wâren vorvluchit von gote (Deut. Myst. 1, 195, 21).

§ 42. The following quotations contain a prepositional phrase introduced by 'in' denoting the direction and goal of the motion of the verb. In addition to this, a pleonastic adverbial 'in' is added as a prefix to the verb. Except for the addition of the prepositional phrase, this group is identical with the one of § 41.

Otfried (9th C.): *ilta in* thia burg *in* zen liuten (2, 14, 86).

faret in thia burg *in* (4, 9, 9).
giang mit kriste er tho fon in *in* thaz sprahhus *in* (4, 23, 30).
ni *quam* noh tho unser druhtin *in* thaz kastel *in* (3, 24, 41).

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[21] Cf. with the above, Parz. 163, 17:

hin în sin *fuorten* al zehant,
da er manegen werden riter vant.

Tatian (9th C.): grab, *in* themo noh nu nioman *ingisezzit* uuas (213, 1).

in skef *instîgenti* (70, 2).

Stretlinger Chronik (15th C.): Do nû der edel herr Wilhelm von Stretlingen heim kam und das heltům und die friheiten mit grossen eren und lob gottes *in* die kilchen des Paradis was *ingefüert* (148, 9).

Keisersberg (15th C.): du solt das gelt *innegen in* den hût der gedult (DWb.).

Luther (16th C.): Diesen *setzet ein in* den Kerker und speiset ihn mit Brot und Wasser des Trübsals (1 Kön. 22, 27).

Friedrich v. Logau (17th C.): sprang und *stürzte* sich *ins* Wasser *ein* (DWb.).

Paul Fleming (17th C.): Auf Nordwind, *lege* dich *in* unser Segel *ein* (DWb.).

Goethe (18th C.): Wir sind auf die hohen Gipfel gestiegen und *in* die Tiefen der Erde *eingekrochen* (DWb.).

Aus einer Gesteinart, deren Wände fast ganz perpendicular *in* die Erde *einschieszen* (16, 247).

Wie ich mich zuletzt *in* den geborgten, abgetragenen grauen Rock *einzwängte* (25, 349).

Schiller (18th C.):

Leben um Leben tausend Siege jeder
Den Dolch *einbohrend in* des andern Brust (DWb.).

Grillparzer (19th C.):

Wenn du damals mir vergönntest
Feuerbrände *einzuschleudern*
In die schreckgeleerten Gassen (Traum IV).

The following are abstract in their meaning.

Luther (16th C.): Nicht *einführ* uns *in* Versuchung (Mat. 6, 13).[22]

Dis ist aber seine Meinung als wir beten ein Vaterunser, und nicht uns *einleit in* Versuchung (DWb.).

Sebastian Frank (16th C.): Das die Kraft inwendig *in* Mark und Gebein sich *einkehre* und versammel (DWb.).

Lohenstein (17th C.): Wil Rom durch ihn (Varus) *in* unser Vaterland der warmen Länder abscheuliche Laster *einspielen?* (DWb.)

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[22] This is the older version for which "führe uns nicht in Versuchung" has now been substituted.

Goethe (18th C.): *In* die italienische Opernform und ihre Vortheile hatte ich mich recht *eingedacht* (31, 10).

Lass uns freudig und munter *in* das *eingreifen*, was die Männer unvollendet zurück gelassen haben (17, 175).

Adam Müller-Guttenbrunn (20th C.): Einige *bogen* laut *in* die milderen Geleise *ein* und rissen die andern mit (Glocken 203).

§ 43. The pleonastic 'in' treated in section 42 occurred as early as Old High German. Later, two other prepositions were introduced to denote 'an entrance into'. The earlier of these was 'zu', itself originally an adverb and denoting 'proximity to', but without further designating the relation. It denoted either rest in close proximity to some object, or motion to such a position. Later, 'zu' developed a step farther and came to mean not only 'contiguous to', but 'within'. Thus, 'zu München' (< 'ze den münechen' = 'at the monastery of the monks'), meant 'in the town at the monastery of the monks', with the emphasis on the town rather than on the monastery.[28] In the following quotations the preposition 'in' with its object in the accusative, could be substituted for 'zu' (ze) without in any way changing the thought of the sentence. In modern German it would, in general, be necessary to add a 'her' or 'hin' to the simple prefix, altho, as in the preceding section, there is still considerable variability in the usage of these prefixes.

Wolfram v. Eschenbach (13th C.): Er *gienc zer* Kemenâten *în* (Parz. 566, 11).

Gottfried v. Strassburg (13th C.): daz er im daz sper *zem* giele *în stach* (Trist. 8981).

dâ wart der werde Riwalîn
mit eime sper *zer* sîten *în*
gestochen und sô sêre wunt (Trist. 1134).

Luther (16th C.): Siehe, Herr, *kehret* doch *ein zum* Hause eures Knechts und bleibet über Nacht (1 Mos. 19, 2).

Da sie *zu* Bethlehen *einkamen* (Ruth 1, 19).

Friedrich v. Logau (17th C.): In guter Ordnung wie die Säu *zum* Thore *laufen ein* (DWb.).

The following show some figurative uses of the combination 'ein . . . zu'.

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[28] The English preposition 'at' has undergone a similar semantic development. This preposition also originally denoted 'near', 'by the side of', but acquired the meaning 'in' in certain phrases. Cf. "I am stopping at the home of my friend."

Gottfried v. Strassburg (13th C.):

Minne, aller herzen lâgærin
sleich zir beider herzen *în* (Trist. 11716).

Luther (16th C.): Musste nicht Christus solches leiden, und *zu* seiner Herrlichkeit *eingehen?* (Luc. 24, 26.)

§ 44. Altho one would expect the accusative case after a verb of motion compounded with 'ein', this case is far less common than the dative, as will be seen in the next section. The following six examples comprise a representative list of compounds governing the accusative case, from the Old High German to the present time. The earliest example is of an abstract idea, but the concrete meaning is more common.

Otfried (9th C.): Thaz lioht ist filu uuar thing, *inliuchtit* thesan uuoroltring (2, 2, 13).

Pfaffe Conrad (12th C.): Got den rât sie *in stiez* (M.).

Johannes Tauler (14th C.): Das Abgrunde das *inleitet* das Abgrunde (M.).

Hans Sachs (16th C.):

Da *trabt* ich gen der linken Hand
Ein Holzweg *ein* mir unbekant (DWb.).
Und als ich stund in den Gedrechten
Welche Straszen ich wolt *eingan* (DWb.).

Opitz (17th C.): Wann du mit kluger Macht das blawe Feld *eindringest* (DWb.).

§ 45. As early as Old High German the goal of the verbal compound, altho denoting motion, was in the dative case. In a great preponderance of cases, this dative, however, was a personal pronoun and had its starting point in a dative of interest. The entering into a person also benefited that person. It is but natural that most of the sentences with such a dative are figurative or abstract. The identity of the beneficiary and the recipient is especially apparent in the quotation from Otfried:

inliuhte imo io thar, uuunna, thia euuiniga sunna! (Ludowicum 96).

Heinrich v. Nördlingen (13th C.): als mir *în liuhtent* dîne wort (L.).

Das Anegenge (12th C.): er *blies* im sinen geist *în* (M.).

Bernger v. Horheim (13th C.):

als ich ir mînen kumber klage,
daz *gât* ir leider lützel *in* (Bartsch 12, 13).

Fastnachtspiele (15th C.): und sollst auch disen allen *stoszen* ain herz *ein* (637, 5).

Keisersberg (15th C.): wen in der bös geist sie (die Gedanken) *in redet,* so musz er (der Mensch) eben tun, als ob ein ander Mensch unfletige ding redet (DWb.).

Luther (16th C.): er [Gott] *bliess* ihm [den Menschen] *ein* den lebendigen Odem in seine Nase (1 Mos. 2, 7).

Und Joab *gab* ir *ein,* was sie reden sollte (2 Sam. 14, 3).

Aimon (16th C.): Mir ist solche Forcht von iretwegen *ingeschossen,* das alles mein Geblüt sich gegen inen ensetzt (DWb.).

Sebastian Frank (16th C.): Ja welches uns nit ein geringe Hofnung *einwirft* (DWb.).

Carolus II starb, nit on Argwon eingenummens Gift von Sedechia einem Juden im zubereit und *eingeschleicht* (DWb.).

Hans Sachs (16th C.):

O herzliche Tochter, ausschlag
Solch Danken aus dem Herzen dein,
Welche dir *speit* der Teufel *ein* (DWb.).

Jörg Wickram (16th C.): Aber dem Pfaffen *trieb* ers wieder *ein* (DWb.).

Joh. Fischart (16th C.): [in den Wein] einreden und einschmeicheln, ist besser als *giesz* man mirs *ein* (DWb.).

All the above quotations have figurative meanings. Those following have concrete force. There are few examples, and these are comparatively late.

Klopstock (18th C.): Um dieser blutigen Krone, die meiner Schläfe sich *eingrub* (C.).

Jean Paul Richter (18th C.): Es war dieselbe Stärke, womit er Psyches Flügelpferde den Zügel straf hielt und das Spornrad *einstiesz* (DWb.).

§ 46. In the combination 'aus . . . ein', the adverbial particles have everywhere retained their original force up to the present time. They have become fixed formulas and do not require the support of 'her' or 'hin'. For examples see § 3.

Part II.

New Meanings Developed by 'Ein'

§ 47. As stated at the beginning of this chapter, the force of 'ein' is still apparent in nearly all of the compounds to which it is prefixed, even when they have acquired a specialized meaning. Altho the idea of motion into a place may have become rather vague, there are many ex-

amples of compounds in which the full force of the adverb is still felt, even when the compounds have acquired a special meaning as a result of having been applied to one certain action by a particular group or class of people for such a long time that the expression has become fossilized. In this section belong chiefly technical expressions employed by various trades, professions, sports, etc.

For each of these classes of people the compound has acquired a definite specialized connotation, altho originally having only the more general force of 'ein' compounded with a verb. Thus 'eintreten' has an entirely different meaning when used by a soldier than when employed by a person welcoming guests. Furthermore, when a musician says: "Ich *setze* nach dem zweiten Takt *ein*"; a gambler says: "Ich habe 10 Mark *eingesetzt*"; or a jeweler: "Ich *setze* den Rubin mit Gold *ein*", '*einsetzen*' in all these cases denotes a passing of some object into another, but the compound, as such, has a very distinctive meaning in each case. Likewise, the same word may assume a specialized meaning when used by persons in different situations.

Reinhart Fuchs (12th C.): Die zagel habent *în gesmogen* [den Schwanz] (M.).

Nibelungenlied (12th C.): eine scharpfe strâle het er dar *in gezogen* [auf den Bogen gelegt] (936, 2).

Hartmann v. Aue (12th C.):

Jane vihtet iu hie nieman mite
der leu enwerde *in getân* (Iwein 6697).

Wolfram v. Eschenbach (13th C.): ir habt mich *în geslozzen* (Parz. 510, 22).

Gottfried v. Strassburg (13th C.): swîget unde *tuot* iuch *în* (Trist. 8703).

der getriuwe marschalc Foitenant
fuor heim und sprach sîn sælic wîp
und bevalch ir verre und an den lîp
daz sî sich *în leite*
nâch der gewoneheite
als ein wîp kindes inne lît (Trist. 1895).
diu tassel, dâ diu solten sîn,
dâ was ein kleinez snuorlîn
von wîzen berlîn *în getragen* (Trist. 10941).

Wirnt v. Gravenberg (13th C.): mit ir goufen truoc si dar des wazzers unde *goz* im *în* (M.).

Monumenta Zollerana (13th C.): einen knecht mit eim pferd *einlegen* (L.).

Leben d. hl. Elisabeth (13th C.): einen *in legen* ('ins Grab legen', L.).

St. Galler Stadtbuch (14th C.): daz nieman enkainen *ingenæten* harnasch tragen sol inrent den gerihten (L.).

Zimmer'sche Chronik: das muss hernach, und dieweil es noch selbiger zeit so frue im jar, das man die stuben nit *einfuret* (L.).

Meister Eckhart (14th C.): Dâvid sprichet 'got ist bî allen den, die in în nement und in *în sprechent* ['einladen'] (Deut. Myst. 2, 102, 30).

Chroniken d. deut. Städte (14th C.): auch haben sie in ausser procht gen Peterwardein und in vor herlich pegangen und *eingemacht* und in sein rittern und knechten überantwortet (3, 412, 10).

wenn die halben schutzen *schüszent*, dâ soltent die wile die andern halben ire bogene *inzihen* (8, 83, 4).

Fastnachtspiele (15th C.):

ir zwen eeprecher mit euren weiben
man wird euch alle fiere *einschreiben*
pisz von heut über acht tag (328, 22).
so ich das ros *einsetzen* wil
do het es verlorn den aftersil (565, 35).
und kunt si in recht *einspannen*
als ander frauen tuon iren mannen (327, 16).

Diplomarium Habsburgicum (15th C.): kuntschaft *einlegen* (L.).

Keisersberg (15th C.): nieswurz, die enthaltet einen menschen vor groszem schaden, so ein arzet einem die vorbereitet hat, und sol die sunst nicht *einnehmen* (DWb.).

FIGURATIVE EXPRESSIONS

Meister Eckhart (14th C.): bekennen wir got in diesem liehte, daz muoz eigen sîn und îngezogen âne allez *înrîsen* deheiner geschaffener dinge (Deut. Myst. 2, 83, 29).

daz von ûzen *în* wirt *gesprochen*, daz ist ein grob dinc: ez ist îngesprochen sprich ez her ûz! (Deut. Myst. 2, 207, 25).

Chroniken d. deut. Städte (14th C.): Item man soll wissen, dasz ain hocher turn . . . auszen gemauert . . . und in der mitte kislingstain mit morter *eingerennt* und gegoszen (5, 315, 5).

The following quotations contain examples of metonymy. They occur only since the New High German period.

Opitz (17th C.):

Der Walfisch vom Haken *eingestochen*
Läszt sich mit einem Nachen ziehen (DWb.).

Günther (18th C.): *Strich* Schlaf und Puls mit Balsam *ein* (DWb).

§ 48. The following quotations contain words meaning 'to capture'. Originally, no doubt, the thought was that of capturing in a net, trap, etc.

Jean Paul Richter (18th C.): Inzwischen is das verdriessliche Gerücht schwerlich wider ***einzufangen*** (DWb.).

Campe (19th C.): ***einwischen*** = 'wischen oder haschen und festhalten'.

§ 49. Closely related to this meaning is that of 'catching up with'. The semantic development is as follows: the verb means 'to capture', then 'to be in a position to capture', that is, 'to catch up with'.

Campe (19th C.): ***einholen*** = uneigentlich, gleich kommen. Einen in Kenntnisse, Geschicklichkeit einholen.

The original concrete idea was to capture and 'fetch into captivity'. Then the idea of 'fetching into' was lost, the emphasis being on the 'ability' to fetch in (after capturing), rather than that act itself.

Grimm (19th C.): beim Laufen ***einkriegen*** = kriegen (DWb.).

§ 50. In § 12 it was shown that an exit of a thing might be identical with its ending, and that in this way the particle 'aus' came to acquire the meaning 'to end'. On the other hand, an entrance into a state or condition, especially if emphasis is laid on the moment of entering, may be identical with 'beginning an existence' in that state or condition. Certain compounds are given this force by the prefix 'ein'.

Deutsche Gedichte d. 11ten u. 12ten Jh.: . . . Do Alberich diz lît ***inslûc,*** do heter ein salemones pûch, da er ane sach (M.).

Gottfried v. Strassburg (13th C.):

nu war diu hôhgezît geleit
benennet unde besprochen
die blüenden vier wochen,
sô der vil süeze meie ***în gât***
unz an daz, dâ er ende hât (Trist. 537).

The figure is that of May entering into the fields and forests. This entrance is identical with beginning. That 'ingan' here means 'to begin', is clear from the phrase "unz an daz, do er ende hat."

Gottfried v. Strassburg (13th C.):

. . . der begunde
einen leich dâ lâzen ***klingen în*** (Trist. 3583).

Friedrich v. Logau (17th C.): Wie wol er gerne Darmgicht bringt, doch geht er ***lieblich ein*** (DWb.).

Geo. Christ. Lichtenberg (18th C.): Was mir bei dem nun ***eintretenden*** Laub gefällt (DWb.).

Goethe (18th C.): Ich habe wieder Fenster, kann wieder Feuer *einmachen* (DWb.).

In present day speech we should say 'Feuer anmachen', 'an' having usurped the function of 'ein' in this sense.

Schiller (18th C.): . . . eine neue Ordnung der Dinge *führt* sich *ein* (C.).

§ 51. The meaning 'to acquire', or literally, 'to enter into possession of', becomes clear when we go back to the earlier examples of its use. The subject gains possession of the object. At first the object was thought of as entering into the subject, or something belonging to the subject. Thus, if I take money into my pocket, I take it into my possession, or as we say, "I take it in." This is one more example of an elliptic sentence with the object into which something enters omitted.

Das alte Passional (13th C.): dô er zu vil *în nam* (gewann) an deme heiligen krûce (M.).

Nicolaus v. Jeroschin (14th C.): vil groziu vromen daz *întrûc* (einbrachte) (M.).

Zürcher Jahrbuch (15th C.): dise vorgeschribenen alle wolten unwiderseit *în genomen* hân die stat zuo Zürich (M.).

Pfarrer v. Kalenberg (15th C.): er kam zu Steuermarck in das lant und *nam* ein newe pfar do *ein* (2123).

Melanchthon (16th C.): Bisz dasz sie [die Stadt] der Kaiser endlich durch Verräterei *einbekam* (DWb.).

Luther (16th C.): Da sie nun gen Capernaum kamen, gingen zu Petrus die den Zinsgroschen *einnahmen* und sprachen . . . (Mat. 17, 24).

Sebastian Frank (16th C.): Und wollen sich bei den Christen wider heilen und ihres Schadens *einkummen* (DWb.).

Opitz (17th C.):

Dasz er sie hat bestritten
Die Hauptstatt *eingekriegt* (DWb.).

Paul Fleming (17th C.): Es ist das hohe Haar der schönen Basilenen, durch welcher Trefflichkeit ich *eingenommen* bin (DWb.).

Lessing (18th C.): Hier kann er einen Brocken Weisheit wieder auskramen den er sich erst gestern *einbettelte* (DWb.).[24]

Dolz (18th C.): Wo Lehrer noch ihre Besoldung *einsingen* müssen (C.).

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[24] That is to say, got into his possession by means of begging.

§ 52. In § 7 a number of verbs were noted to which the prefix 'aus' gave the force 'to extend', 'to expand'. The opposite meaning has been developed by a small group of verbs when compounded with 'ein', namely, 'to contract', 'to decrease in compass'. The underlying thought of this development is clearly distinguishable in the quotation from Konrad v. Würzburg (13th C.):

> an füez und an henden wâren im die ballen so gänzlich *în gevallen* (M.).

There is a receding inward of the balls, that is, an entrance into themselves. As an object enters into itself there is an accompanying decrease of its compass, a shrinking.

Gottfried v. Strassburg (13th C.):

> sîn ors daz habete ein knappe dâ
> in Spanienland noch anderswâ
> wart nie kein schœnerez erzogen
> ezn was niender *în gesmogen*
> [eingefallen] (Trist. 6666).

Chroniken d. deut. Städte (14th C.): und also ward sich nun der krieg *einzeren* ie lenger ie fester (5, 245, 31).

Gryphius (17th C.): die *eingeschrümpften* Wangen (DWb.).

Gotter (18th C.): Die *eingesunkenen* Wangen (DWb.).

Goethe (18th C.):

> Der Sänger *drückt* die Augen *ein*
> Und schlug die vollen Töne (18, 206).

Jean Paul Richter (18th C.): Die Sonne *kroch* jetzt *ein* zu einem einzigen rothen Strahl (DWb.).

Adam Müller-Guttenbrunn (20th C.): . . . und die Schneeberge in den Strassen begannen allmählich *einzusinken* (Glocken 237).

§ 53. Closely related to the above idea of a motion inward into itself, in fact but one phase of it, is that of forcing a thing into itself. If the thing is hollow, there can be but one result, namely 'a collapse', which is equal to 'a destruction' of the object in question. The following list contains both transitive and intransitive verbs having this meaning.

Chroniken d. deut. Städte (14th C.): da in kurz vergangner zeitt der wirdig convent gotz hausz und closter . . . schwärlichen beschedigt und gantz alles uncz allain an die kirchen ze grund *eingebrannt* ist (5, 243, Anm. 1).

Der Hürnen Seyfried (16th C.):

der berg müsste *einfallen*
das es seyn leben verlür (133, 7).

Luther (16th C.): Ich will Samaria zum Steinhaufen im Felde machen, die man um die Weinberge legt, und will ihre Steine in das Tal schleifen und zu Grunde *einbrechen* (Micha 1, 6).

Und will eure Städte wüste machen und eures Heiligthums Kirchen *einreissen* (3 Mos. 26, 31).

Opitz (17th C.): Sie sehen wol, dasz jetzt von vielen schönen Städten noch kaum der Name lebt, sie selbst sind *eingetreten,* verheert und ausgebrannt (DWb.).

Mühlpfort (17th C.): Verwirfst du diesen auch den deine Hand gebaut? Und *stöszt* der Meister selbst sein Meisterstück jetzt *ein?* (DWb.)

Schiller (18th C.):

Jetzt oder nie, wir sind allein,
Der Etikette bange Scheidewand
Ist zwischen Sohn und Vater *eingesunken* (DWb.).

Jean Paul Richter (18th C.): Weil die Ehrenpforte *einpurzelt* (DWb.).

Und erwägst Du deine Mittänzerin, die ja schamroth und leichenblas wird *einsinken* (C.).

Tieck (19th C.): So viel ich weiss, hat man keins der geschmackvollen zierlichen Komödienhäuser, ja keine . . . Loge in Trümmer blasen und *einschreien* können (DWb.).

§ 54. As 'aus' added to a verb may denote either that the action of the verb is beginning or that it has come to an end, and since 'ein' was already shown to give to the verb the idea of beginning, it is not surprising that 'ein' has likewise developed the meaning 'to end', 'to put a stop to'. It is conceivable for this latter meaning to have grown out of the one treated in the section just preceding, since a thing usually ends when it is destroyed. On the other hand, altho highly figurative, the thought underlying most of the verbs with this force, seems to be that of putting into a place of safe keeping, or withdrawing from an exposed position.

Keisersberg (15th C.): ich hab ainest neun Prediger davon gethon zů den Reuweren zu Straszburg, aber ich můsz es ietz zu den Orten *einschlagen* (= 'einstellen', 'unterlassen', DWb.).

Hans Sachs (16th C.):

Der wirt sein Bulerei *einziehen,*
Das sunst nieman wirt innen mehr (DWb.).

Hans Schweinichen (17th C.): so bäte ich noch eins, i. f. gn. wollten es ***einstellen*** (DWb.).

Gellert (18th C.): Carlson blieb auf einer Stelle stehen und fragte huntertmal, was es wäre. Mein Mann wollte es ihm sagen und ***kehrte*** doch bei jedem Wort wieder ***ein*** (DWb.).

§ 55. In one group of compounds the prefix 'ein' gives ingressive force to durative verbs, that is, denotes an entrance into a condition, especially that of sleep and related states. Sleep, which is personified, receives into her embrace or care, the object, usually a person, by means of the action denoted by the verb.

Friederich v. Spee (17th C.):

Nahm ein Röhrlein wolgeschnitten,
Spielet seinen Wässerlein,
Sie zum Schlafen tät erbitten
Wollt sie süsslich ***sausen ein*** (DWb.).

Goethe (18th C.):

Meine Töchter führen den nächtlichen Reihn
Und ***wiegen*** und ***tanzen*** und ***singen*** dich ***ein*** (Erlkönig 20).

Jean Paul Richter (18th C.): Er musste das innere Steppenfeuer auf das Kopfkissen betten und in sein ***Einträumen*** mischte sich der hohe Donner (DWb.).

Gökingk (19th C.):

Meines Weibchens, das den Jungen
Eben itzt hat ***eingesungen*** (DWb.).

Grimm (19th C.): ***eingeigen*** = mit Geigenspiel einschläfern (DWb.).

§ 56. In §§42, 43, the prepositions 'in' or 'zu' in connection with the adverbial particle 'ein' were found to affect a sentence very little, if at all. Their function seems to have been merely to intensify the force of the prefix. 'Bei', however, adds a definite idea to those sentences in which it occurs in conjunction with a verbal compounded with 'ein'. In general, it may be said that the verb has acquired a special meaning, which is no longer clearly visualized, and that, in the majority of cases, we have to deal with a figurative idea. The object of the preposition is always a person or group of persons thought of collectively.

Hans Sachs (16th C.): Das sich nichts args ***bey*** in [ihnen] ***einpflantz*** (C.).

Friederich v. Logau (17th C.): Die Gicht ***bricht*** grob genug ***bei*** wem sie ankümmt ***ein*** (DWb.).

Stieler (17th C.): Die Kupplerin hat ihn *bei* der Jungfrau *eingeliebelt* (DWb.).

Lessing (18th C.): Unter dem Vorwande, dass er und seine Freunde mit verschiedenen Urtheilen nicht zufrieden wären, *langte* er nicht blosz seine Läuterungen desfalls *bei* dem Publico *ein,* sondern errichtete selbst ein Tribunal (DWb.).

§ 57. As in the examples listed in the preceding section, the situations in the sentences at the end of this one are no longer clearly visualized. The idea expressed in the group 'auf . . . ein . . . verb' is one of approach, usually with some thought of violence, or at least vehemence, already contained in the simple verb. The preposition has the same force as: "Er kam auf mich zu," 'he came toward me', that is, it denotes direction toward something; while the compound with 'ein' is a remnant of a faded metaphor.

Lessing (18th C.): Nur immer mit einzelnen Beispielen *auf* mich *einstürmen* (DWb.).

Mit diesem Dolch kommen sie *auf* mich *eingerannt* . . . (DWb.).

Jean Paul Richter (18th C.): Wie der Hauptmann mit dem wachsenden Sturme *auf* ihn furchtlos *einblitzte* (DWb.).

Auch *rauscht* nicht eben die ganze Volksmenge *auf* den Menschen *ein* (DWb.).

Campe (19th C.): Nicht selten *jagen* sie (die Türkischen Kampfspieler) so wild *auf* einander *ein,* dass man glauben sollte, sie müssten einander über den Haufen rennen.

H. v. Kleist (19th C.): Das Tier *schoss* . . . mit wutherfüllten Sätzen *auf* mich *ein* (S.).

Karl Friedr. Becker (19th C.): Er *fuhr* dergestalt mit Drohungen *auf* sie *ein* (S.).

Friedr. Müller (19th C.): Neues *auf* mich *einstürzendes* Entzücken (DWb.).

Gutzkow (19th C.): Der Kutscher *schlug auf* die Pferde *ein* (S.).

§ 58. As the prefix 'ein' may denote that some one gains possession of a thing by means of an action indicated by a verb, this figure may be extended from a material to a mental acquisition. Acquiring a thing mentally gives one a knowledge of it and an accompanying proficiency in it. On the one hand the knowledge may be thought of as entering into the object by means of the action of the verb. On the other hand,

the figure may be that of an object mastering a thing by entering into it, by absorbing it, by means of frequent repetition or intensity of application. For instance, 'ein Pferd einreiten' means to ride a horse until it has become familiar with the art of being ridden. This figure may be transferred to an inanimate object, 'ein Gewehr einschiessen'.

Goethe (18th C.):

Habt euch vorher wohl praepariert,
Paragraphos wohl *einstudiert* (Faust 1959).

Jean Paul Richter (18th C.): In die Correcturzeichen hatt' er sich längst *eingeschossen* (DWb.).

Campe (19th C.): Ich habe mich schwer in die Sache *eingearbeitet*.

Ein Stück gut *eingeigen*.

Einen Hund *einhetzen*.

Eintanzen = einen Tanz einüben, sich eintanzen.

Brandis (19th C.): Hätten beide Sutsos tiefer in die Geschichte und in die Dichtkunst der hellenischen Vorzeit sich *eingelebt*, wie ungleich bedeutendere Dichter würden sie sein (DWb.).

§ 59. There are a few compounds in which the prefix 'ein' adds scarcely anything, at most merely intensifying the verb. Their significance for this study lies in the fact that the adverbial prefix has become weakened to such a degree that it no longer affects the verb.

Luther (16th C.): Alsdann sollt ihr wieder umkehren in euer Land, das euch Mose *eingegeben* hat zu besitzen (Jos. 1, 15).

Und das alles wider das *Einsagen* der Jüden, die nicht wöllen, das Maria ein Jungfrau Mutter sei (DWb.).

Goethe (18th C.): Als durch einen gewissen Halbgeschmack die lustige Person vertrieben ward, und obgleich geistreiche Köpfe für sie einsprachen, dennoch weichen musste (26, 195).

§ 60. In several compounds the prefix 'ein' has given place to some other prefix. This is due to the fact that in a number of instances the several prefixes have developed identical force.

Goethe (18th C.): Ich habe wieder Fenster, kann wieder Feuer *einmachen* (= 'anmachen', DWb.).

Grimm (19th C.): Ich kann den Stiefel nicht *einkriegen* (= 'ankriegen', DWb.).

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Anmutig Thal! du immergrüner Hain
Nehmt freundlich mich in eure Schatten *ein* ('aufnehmen').
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§ 61. The following quotation from Lessing is added, not because it represents any particular development of 'ein' or the compound, but merely for the sake of completeness, because it is a curiosity brought down from by-gone times. The genitive is an old adverbial genitive.

Lessing (18th C.): Wir Wirte sind angewiesen, keinen Fremden, wes Standes und Geschlechts er auch sei, vierundzwanzig Stunden zu behausen, ohne seinen Namen . . . gehörigen Orts *einzureichen* (Minna v. Barnhelm 2, 2).

Part III.

'Herein' and 'Hinein' with their Original Force

§ 62. Similarly, as in the case of the prefixes 'heraus' and 'hinaus', the early German language contains very few examples of the prefix 'herein' and 'hinein', the simple prefixes 'aus' and 'ein' being sufficient by themselves to express the idea of motion toward or away from the speaker, the direction being indicated by the context.

When Otfried writes, "zi thiu *quam* ih hera in uuorolt *in*" (4, 21, 29), he gives 'hera' its old demonstrative force, 'toward this place'. In the following sentence, also from Otfried, the original force of 'hin' is shown: *farames* auur thara zi in, *hina* in iro lant *in* (3, 23, 28). The force of 'in faran' is nearly identical with modern German 'hineinfahren'. 'Hin' is a demonstrative adverb strengthening 'thara'. It is evident that to Otfried 'hin in faran' had not yet formed a compound in the present sense of that term. For him each of the words possessed full individual force.

§ 63. Graff records two Old High German passages in which there seems to be no doubt that the particles 'hera in' form a compound with their respective verbs. But neither in Tatian nor in Otfried's Gospel Harmonies are there examples of such compounds. The following is a relatively complete list of examples from Old High German and Middle High German records. Besides the two Old High German quotations recorded by Graff, Middle High German is represented by five verbs compounded with 'herein', while in seven verbs the prefix 'hinein' is used.

Boethius (9th C.): uuer *liez hara in* ze disemo siechen tise huorra (G.).

Old High German (10th C.): hueo *quam* du *hera in* (G.).

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Hartmann v. Aue (12th C.):

er sprach 'ich hân daz wol bedâht
daz ich iuch hân *her in brâht*' (Iwein 6180).

dô er noch lützel hêt geseit,
do erwachte die künegin
und hôrte sîn *sagen hin in* ['into that place'] (Iwein 98).

vür eine verrâtærinne
bin ich dâ *her in geleit* (Iwein 4049).

sus *wurfen* sî mich dâ *her in* (Iwein 4171).

Wolfram v. Eschenbach (13th C.):

dô des ûzern hers gast
innen wart daz im gebrast
dienst dankes von dem meister sîn
(der was *gevangen hin în*),
er reit da er sîne knappen sach (Parz. 388, 14).

hin în sin *fuorten* al zehant,
da er manegen werden riter vant (Parz. 163, 17).

für daz poulûn dô reit
zwên ritter ûf ir sicherheit,
die wârn *hin ûz gevangen*,
und kômn *her în gegangen* (Parz. 85, 8).

Gottfried v. Strassburg (13th C.):

nu sî von dem gevilde
verre *hin în kâmen* (Trist. 12775).

Konrad v. Megenberg (14th C.): daz winterzeiten die warmen dünst *hin ein* in daz ertreich *slahent*, aber sumerzeiten *slahent* si *her auz* (M.).

Stretlinger Chronik (15th C.): . . . und liess ir machen ob der grossen kilchtür, da man vor *hin ingat*, ein porkilchen (84, 30).

. . . und *reit* also *hinin* in Lamparten in die statt Cremonensis (92, 11).

§ 64. It is evident that 'her' and 'hin' of the double prefixes 'herein', 'hinein', were just being introduced during Old High German times, and had not yet become widely adopted as late as the end of the 14th century. The first element of the prefix was introduced to give added force to the simple prefix 'in', that is, to point out more clearly the direction of the motion of the verb in relation to the speaker. But, as in the case of 'heraus', 'hinaus', a weakening of this force is noticeable at a comparatively early date. It is interesting that the confusion of the two particles 'her' and 'hin' so common to modern German, appears as early

as the beginning of the 13th century, when we should expect the people still to be conscious of the full force of the demonstrative particle.

Hermann v. Fritzlar writes: dô *lif* si ***hin în hin*** zu deme kunige unde sprach (Deut. Myst. 1, 189, 40).

It is clear that he no longer felt the force of 'hin' in 'hinîn', hence added another pleonastic 'hin' to make clear the motion 'away from'. 'Herein' suffered a similar loss, as the following quotation shows.

Pfarrer v. Kalenberg:

wolt got und wer ich vor der thüer
der teuffel *precht* mich nit ***herein***
her wider in des pfarrers hauss (1860).

One 'her', either the adverb or the prefix, is superfluous for our present feeling in the matter. This apparent tautology can be explained only if we assume, that for the author of this poem, 'herein' no longer denoted 'motion into and toward', but only 'motion into'. Hence he added a second 'her' to make clear this motion toward the speaker.

§ 65. In modern German the spread of the double prefixes 'herein' and 'hinein' was nearly parallel to that of 'heraus' and 'hinaus'. From Old High German and Middle High German there are recorded eight more verbs compounded with the latter prefixes. The type of verbs which takes the former two, does not differ from that taking the latter double prefixes. Hence the ratio of 22 : 14 is significant as showing the greater vitality of 'ein', which did not require the aid of the demonstrative particle to retain its old force as early nor to such an extent as 'aus'.

The number of verbs with the double prefix with 'aus', and those with 'ein', shows less discrepancy since the beginning of the New High German period than for Middle High German, as will be seen by comparing § 23 with the statistics at the end of this section. At the present time the number of verbs for each is almost equal. This is as might be expected, for potentially they are equal. One interesting fact, however, may be observed, namely, 'her' has been more frequently prefixed to 'aus', while 'hin' is more frequently prefixed to 'ein'. If we deduct the words introduced by Campe as of doubtful merit, we find that there are nearly three times as many verbs compounded with 'heraus' as with 'hinaus', while the inverse ratio holds for 'herein' as compared with 'hinein'.[25]

[25] As stated in § 24, Campe formed many compounds with 'hinaus' in analogy to those with 'heraus' already existing in the language, hence the ratio of verbs with 'heraus' and 'hinaus' has been artificially disturbed. For 'herein' and 'hinein' he followed an inverse process.

§ 68. In several instances the compound with 'herein' has become so highly specialized as a result of the paling of an old figure, that there is no feeling at all of direction, either toward or away from the speaker. This is evidently the case in the following quotation:

Luther (16th C.): Sie weren wol werd, beide Beschleffer und Beschlefferin, das sie zum wenigsten eine Zeitlang das Land müssten reumen, damit das Ergernis gebüszet oder *herein bracht,* und den andern ein Exempel zur Furcht gegeben wurde (DWb.).[26]

Wie denn seine (des Moses) Weise ist, das er oft so *herein feret,* und also redet, das jedermann vestehet (DWb.).

Hie *fellet herein* (in d. Untersuchung) die alte Frage welcher Evangelist . . . die veterliche Schnur beschriebe (DWb.).

Ew. Gestrengen wollen sich unbeschwert *hereinfinden* (DWb.).

§ 69. A few compounds denote an 'entering' into our senses, for example, into our range of vision, or of hearing. There can be no visualization of a motion into something in these cases, but there is an idea of an approaching toward the speaker, in all of the following examples. Usually there is a reference to some natural phenomenon.

Luther (16th C.): Wenn wir diese Zeichen sehen mit Feuer, Wasser, Blitz, und Donner *hereinschlagen* (S.).

Luther probably thought of some extramundane being hurling the elements in upon the earth. Obviously this being is above the world, and the motion is assumed as coming downward. It is in a similar figure that most of the following expressions must have had their origin. In nearly all of them it would be possible to substitute 'herab' or 'hernieder' for 'herein' without in any way changing the thought.

Lessing (18th C.): Der schwüle Tag vergeht, der Abend *bricht herein* (DWb.).

Jean Paul Richter (18th C.): Das *hereinhängende* Himmelblau schien ihm eine dünne blaue Wolke (DWb.).

Von den Höhen *klangen* Alphörner *herein* (C.).

Aber als er innen in der Finsternis mit dem Kopfe am Felsen lehnte und die Töne neckend *hereinspielten* (DWb.).

Rosegger (19th C.): Ueber dieser (der Stirn) hingen quer ein paar rötlichblonde Haarlocken herein, bis zu den runden, ziemlich tiefliegenden Augen (Peter Mayr 7).

[26] Cf. Schiller: Ihr Versäumnis *herein* zu *bringen* und ihre Fehler zu verbessern (DWb.).

The idea expressed by Rosegger is sufficiently clear, but the force of 'herein' is not very evident.

§ 70. The simple prefix 'ein' frequently occurs with prepositional phrases introduced by 'in' or 'zu'. These denote the goal of the motion of the verb. Both of these prepositions occur with the double prefix. The preposition 'in' is of too common occurrence in this connection to require special treatment. A few quotations with 'zu' will suffice.

Luther (16th C.): er *führte* mich ***hinein zum*** Thore an des Herren Haus (Hes. 8, 14).

Jesus *gieng zum* Tempel Gottes ***hinein*** (Mat. 21, 12).

Goethe (18th C.): er *schüttet* die *Pfeile* zum Feuer ***hinein*** (DWb.).

§ 71. A large number of verbal compounds with 'ein' in its old force have come down to us as fossilized forms. Most of these have not been supplemented by a verb with the double prefix. Some writers, however, have coined an intensive form with 'herein' or 'hinein', which is a little stronger than the form with the simple prefix.

Luther (16th C.): Als wenn einer dem andern ein Trunk reichet und spreche, nemet hin, trinkt, hie sitze ich Hans mit den roten Hosen . . . oder *füret* sonst desgleichen einen Bossen ***herein,*** der sich gar nichts aufs Trinken reimet (DWb.).

H. Chr. Fuchs (17th C.):

Hat mich doch mein Schwager getrost
Mir kecken Mut *gepflantzt* ***hinein*** (DWb.).

Grimmelshausen (17th C.): Geschirr . . . den Wein von Palmen *hineinzufangen* (DWb.).

Goethe (18th C.): Wenn ich, auf morgen früh, dich ***hinein*** in meine Wohnung *lade* (9, 364).

Jean Paul Richter (18th C.): Ich hatte heute eine . . . Freude an erbärmlichen Sitten, dass ich mir jeden Bissen ***hinein*** *predigen* liess. (DWb.).

Wilbrandt (20th C.): . . . ich kenne die Verhältnisse nicht, ich *mische* mich nicht ***hinein*** (Osterinsel 416).

Westermann's Monatshefte (1914): "Anleitung zu Lektüre" nennt es sich [R. M. Meyer's Büchlein], und es will allen Freunden deutschen Schrifttums den Weg zeigen, auf dem sie sich am besten in die deutsche Literatur ***hinein-*** und wieder ***herauslesen*** (Editorial p. 788).

§ 72. There is one instance in which the goal of the motion of a verb compounded with 'hinein' is in the accusative. It is possible that this accusative is the object of a prepositional phrase, the preposition having been omitted to meet the requirements of the meter. There are no examples of the goal being in the dative, while for the simple prefix this case is common.

Goethe (18th C.): Und so *trabt'* er die Höhle *hinein* (40, 202).

§ 73. The following are words taken from mining terminology. It is natural that men working in mines should have occasion to make frequent use of the particle 'herein' in various connections. These have come to acquire a specialized meaning for that trade.

Campe (19th C.): *hereinschlagen* = Massen Gesteins los schlagen, und so in den Schacht herein befördern.

Veith: *hereingehen* = in den Schacht stürzen (Bergwörterbuch 272).

hereinkeilen = die zu gewinnenden Massen mit Keilen loslösen, und so in den Schacht herein fallen lassen (Bergwörterb. 272).

hereinreissen = Kohle und Gestein so reissen, dass sie in den Schacht hereinfallen (Bergwörterb. 272).

hereinschiessen = eine anzugreifende Gesteinmasse mittels Schiessens lossprengen (Bergwörterb. 272).

hereintreiben = die zu gewinnenden Massen in grösseren Stücken loslösen (Bergwörterb. 272).

SUMMARY

§ 74. The following points were brought out in this chapter.

1). The original function of 'ein' was that of an adverb denoting motion into an enclosed space. In a few instances 'ein' was used in connection with a verb of rest, but this was the result of a confusion of ideas or of confusion with 'inne', the old adverb of rest.

2). 'Ein' retained its vitality longer than 'aus', many old compounds having come down to the present time. But it is no longer an active prefix.

3). The pleonastic use of the prefix 'ein' with phrases introduced by 'in' or 'zu', shows a weakening of the force of the particle as early as Old High German.

4). The semantic development of 'ein', tho not so great as that of 'aus', tended to restrict further use in its original function.

5). The semantic development of 'ein' began during the earlyMiddle High German period, but most of the new meanings did not arise until after the time of Luther.

6). The functional weakening (indicated by 3) and the spread of specialized uses of 'ein' (4), necessitated the introduction of some other element to denote the force surrendered by 'ein'. 'Her' and 'hin' were prefixed to 'ein' for this purpose.

7). 'Herein' and 'hinein' as prefixes to verbs, make their first appearance during the Old High German period, altho missing for Otfried and Tatian. They are still very sparingly used during Middle High German times, but are already common by the time of Luther, with a function formerly possessed by the simple prefix.

8). The double compound is showing a tendency toward specialization. But this tendency does not antedate the 18th century. Nowhere are there any signs of a semantic development such as the simple compound has undergone.

9). There are more than three times as many verbs with 'hinein' as with 'herein'. (Cf. § 23 and § 65.)

It is suggestive that, while Campe has coined seventy-five per cent more verbs with 'herein' than with 'hinein', more than twice as many of the latter as of the former have been accepted by 19th century writers.

STATISTICS ON THE SPREAD OF 'HEREIN' AND 'HINEIN'.

	'HEREIN'	'HINEIN'	TOTAL
Old High German period	2		2
Middle High German period . .	5	7	12
Luther	5	27	32
Rest of 16th Century	3	9	12
17th Century	7	18	25
Goethe	8	11	19
Rest of 18th Century	13	60	73
Campe	95 (8)	55 (14)	150
19th Century	3	21	24
	141	208	349

PART IV.

NEW MEANINGS ACQUIRED BY 'HEREIN' AND 'HINEIN'

§ 66. In modern German speech the confusion of 'herein' and 'hinein' is of common occurrence. It is due to the fact that for some speakers 'her' and 'hin' no longer possess the force which originally belonged to them. The motion of the verb is not clearly visualized as being directed toward or away from the speaker. Very often the confusion is psychologically accounted for by a preceding sentence logically containing one or the other prefix, which is then repeated by another speaker when, from his standpoint, the motion of the verb is in an entirely opposite direction from that denoted by the first speaker. A good example of the influence of such a statement on a following reply is found in Hartmann v. Aue's Iwein. Lunet, imprisoned in a tower, says to Iwein:

> sus schiet ich âne kempfen dan [from Arthur's court]
> des wart ich sô ze spotte hie
> daz es mir an mîn herze gie.
> sus *wurfen* sî mich dâ *her in* [into the tower] (4171).

Since she is inside and speaking of herself, 'her in' is what we expect. A few lines farther along Iwein, referring to her plight, says:

> zwâre ich trûwe wol gesigen
> an den ritern allen drin,
> die iuch *geworfen* hânt *her in* (4226).

By no logical process could this 'her in' be explained, since Iwein is outside the chapel and cannot possibly have had in mind any idea of

approach toward himself. Altho several speeches intervene between Lunet's use of 'her in werfen' and Iwein's use of the same phrase, he has unconsciously retained her own expression, which he now employs. The force of the verb 'werfen' may have made a strong impression on him. There were several other expressions which a Middle High German speaker might have used, for example, 'hin in sperren' or 'hin in tun'; while Lunet herself uses 'her in legen'. (Cf. 4049.) Other examples of a confusion of the two prefixes are:

Pfarrer v. Kalenberg (15th C.):

> ir müste do ***her eine gan,***
> do innen sitzet mein schuster (1408).

Kaspar Scheid (16th C.):

> wolan disz buch hat schier ein ort . . .
> so wil ich jetzundt, hab ich glück,
> etlich probierte gute stück
> zur letzt auch ***schreiben*** gleich ***herein*** (DWb.).

Goethe (18th C.): Dem sechzehnten Brief . . . wollen wir sein Wohlgedachtes nicht abläugnen, doch quilt auch da nichts aus der Seele, es ist so alles in die Seele ***hereingedacht*** (33, 94).

> Sie hat darin (in der Menagerie) die wunderbarsten Thiere,
> Und ***kriegt*** sie ***rein,*** weiss selbst nicht wie (2, 90).

Goethe is giving vent to his feelings concerning Lili Schönemann, whom he is comparing to Circe. He starts out his poem objectively, standing off at a distance and describing the wiles of his betrothed, who has inveigled numerous men into her net (Menagerie). But unconsciously Goethe turns to a subjective attitude, for the matter concerns him too, since he is one of the captured animals, hence thinks of himself as in the park. Therefore he uses 'herein' instead of 'hinein'.

Raabe (19th C.): . . . nachdem er sich halbwegs ***herein gefunden*** hatte, zeigte er sich nicht besser als jeder andere Schlingel (Hungerpastor 24).

§ 67. The following quotations show that the same confusion occurs regarding the use of 'hinein' for 'herein', but not to quite the same extent.

Wieland (18th C.):

> Wir werden nie zu weise noch zu alt,
> Ihr (Thorheit) süszes Gift mit Lust ***hinein*** zu ***trinken*** (DWb.).

Frenssen (19th C.): Dann fing der alte Mann an von alten Zeiten zu sprechen, bis in die Gegenwart ***hinein*** (Sandgräfin 29).

§ 68. In several instances the compound with 'herein' has become so highly specialized as a result of the paling of an old figure, that there is no feeling at all of direction, either toward or away from the speaker. This is evidently the case in the following quotation:

Luther (16th C.): Sie weren wol werd, beide Beschleffer und Beschlefferin, das sie zum wenigsten eine Zeitlang das Land müssten reumen, damit das Ergernis gebüszet oder *herein bracht,* und den andern ein Exempel zur Furcht gegeben wurde (DWb.).[26]

Wie denn seine (des Moses) Weise ist, das er oft so *herein feret,* und also redet, das jedermann vestehet (DWb.).

Hie *fellet herein* (in d. Untersuchung) die alte Frage welcher Evangelist . . . die veterliche Schnur beschriebe (DWb.).

Ew. Gestrengen wollen sich unbeschwert *hereinfinden* (DWb.).

§ 69. A few compounds denote an 'entering' into our senses, for example, into our range of vision, or of hearing. There can be no visualization of a motion into something in these cases, but there is an idea of an approaching toward the speaker, in all of the following examples. Usually there is a reference to some natural phenomenon.

Luther (16th C.): Wenn wir diese Zeichen sehen mit Feuer, Wasser, Blitz, und Donner *hereinschlagen* (S.).

Luther probably thought of some extramundane being hurling the elements in upon the earth. Obviously this being is above the world, and the motion is assumed as coming downward. It is in a similar figure that most of the following expressions must have had their origin. In nearly all of them it would be possible to substitute 'herab' or 'hernieder' for 'herein' without in any way changing the thought.

Lessing (18th C.): Der schwüle Tag vergeht, der Abend *bricht herein* (DWb.).

Jean Paul Richter (18th C.): Das *hereinhängende* Himmelblau schien ihm eine dünne blaue Wolke (DWb.).

Von den Höhen *klangen* Alphörner *herein* (C.).

Aber als er innen in der Finsternis mit dem Kopfe am Felsen lehnte und die Töne neckend *hereinspielten* (DWb.).

Rosegger (19th C.): Ueber dieser (der Stirn) hingen quer ein paar rötlichblonde Haarlocken herein, bis zu den runden, ziemlich tiefliegenden Augen (Peter Mayr 7).

[26] Cf. Schiller: Ihr Versäumnis *herein* zu *bringen* und ihre Fehler zu verbessern (DWb.).

The idea expressed by Rosegger is sufficiently clear, but the force of 'herein' is not very evident.

§ 70. The simple prefix 'ein' frequently occurs with prepositional phrases introduced by 'in' or 'zu'. These denote the goal of the motion of the verb. Both of these prepositions occur with the double prefix. The preposition 'in' is of too common occurrence in this connection to require special treatment. A few quotations with 'zu' will suffice.

Luther (16th C.): er *führte* mich *hinein zum* Thore an des Herren Haus (Hes. 8, 14).

Jesus *gieng zum* Tempel Gottes *hinein* (Mat. 21, 12).

Goethe (18th C.): er *schüttet* die *Pfeile* zum Feuer *hinein* (DWb.).

§ 71. A large number of verbal compounds with 'ein' in its old force have come down to us as fossilized forms. Most of these have not been supplemented by a verb with the double prefix. Some writers, however, have coined an intensive form with 'herein' or 'hinein', which is a little stronger than the form with the simple prefix.

Luther (16th C.): Als wenn einer dem andern ein Trunk reichet und spreche, nemet hin, trinkt, hie sitze ich Hans mit den roten Hosen . . . oder *füret* sonst desgleichen einen Bossen *herein,* der sich gar nichts aufs Trinken reimet (DWb.).

H. Chr. Fuchs (17th C.):

Hat mich doch mein Schwager getrost
Mir kecken Mut *gepflantzt hinein* (DWb.).

Grimmelshausen (17th C.): Geschirr . . . den Wein von Palmen *hineinzufangen* (DWb.).

Goethe (18th C.): Wenn ich, auf morgen früh, dich *hinein* in meine Wohnung *lade* (9, 364).

Jean Paul Richter (18th C.): Ich hatte heute eine . . . Freude an erbärmlichen Sitten, dass ich mir jeden Bissen *hinein predigen* liess. (DWb.).

Wilbrandt (20th C.): . . . ich kenne die Verhältnisse nicht, ich *mische* mich nicht *hinein* (Osterinsel 416).

Westermann's Monatshefte (1914): "Anleitung zu Lektüre" nennt es sich [R. M. Meyer's Büchlein], und es will allen Freunden deutschen Schrifttums den Weg zeigen, auf dem sie sich am besten in die deutsche Literatur *hinein-* und wieder *herauslesen* (Editorial p. 788).

§ 72. There is one instance in which the goal of the motion of a verb compounded with 'hinein' is in the accusative. It is possible that this accusative is the object of a prepositional phrase, the preposition having been omitted to meet the requirements of the meter. There are no examples of the goal being in the dative, while for the simple prefix this case is common.

Goethe (18th C.): Und so *trabt'* er die Höhle *hinein* (40, 202).

§ 73. The following are words taken from mining terminology. It is natural that men working in mines should have occasion to make frequent use of the particle 'herein' in various connections. These have come to acquire a specialized meaning for that trade.

Campe (19th C.): ***hereinschlagen*** = Massen Gesteins los schlagen, und so in den Schacht herein befördern.

Veith: ***hereingehen*** = in den Schacht stürzen (Bergwörterbuch 272).

hereinkeilen = die zu gewinnenden Massen mit Keilen loslösen, und so in den Schacht herein fallen lassen (Bergwörterb. 272).

hereinreissen = Kohle und Gestein so reissen, dass sie in den Schacht hereinfallen (Bergwörterb. 272).

hereinschiessen = eine anzugreifende Gesteinmasse mittels Schiessens lossprengen (Bergwörterb. 272).

hereintreiben = die zu gewinnenden Massen in grösseren Stücken loslösen (Bergwörterb. 272).

SUMMARY

§ 74. The following points were brought out in this chapter.

1). The original function of 'ein' was that of an adverb denoting motion into an enclosed space. In a few instances 'ein' was used in connection with a verb of rest, but this was the result of a confusion of ideas or of confusion with 'inne', the old adverb of rest.

2). 'Ein' retained its vitality longer than 'aus', many old compounds having come down to the present time. But it is no longer an active prefix.

3). The pleonastic use of the prefix 'ein' with phrases introduced by 'in' or 'zu', shows a weakening of the force of the particle as early as Old High German.

4). The semantic development of 'ein', tho not so great as that of 'aus', tended to restrict further use in its original function.

5). The semantic development of 'ein' began during the earlyMiddle High German period, but most of the new meanings did not arise until after the time of Luther.

6). The functional weakening (indicated by 3) and the spread of specialized uses of 'ein' (4), necessitated the introduction of some other element to denote the force surrendered by 'ein'. 'Her' and 'hin' were prefixed to 'ein' for this purpose.

7). 'Herein' and 'hinein' as prefixes to verbs, make their first appearance during the Old High German period, altho missing for Otfried and Tatian. They are still very sparingly used during Middle High German times, but are already common by the time of Luther, with a function formerly possessed by the simple prefix.

8). The double compound is showing a tendency toward specialization. But this tendency does not antedate the 18th century. Nowhere are there any signs of a semantic development such as the simple compound has undergone.

9). There are more than three times as many verbs with 'hinein' as with 'herein'. (Cf. § 23 and § 65.)

CHAPTER III.

AB, HERAB, HINAB

§ 75. 'Aus' and 'ein' were originally adverbs of direction pointing out a relation to the interior of a thing. 'Aus' referred to a motion from the interior outward, 'ein' to a motion in an opposite direction, namely, into a thing. The other adverbial particles treated in this study, were more general in their application. 'Auf' denoted an upward motion. 'An' pointed out that the motion extended 'up to' a thing. 'Ab' denoted a departure from a surface. But there are two very distinct surfaces to an object to be considered here, namely, the superior and the lateral surfaces, the bottom of an object, upon which it normally rests, rarely offering a point of approach or departure. To the mature mind the two positions represent two very distinct conceptions, expressed by different adverbs (prepositions), 'auf' and 'an' in modern German. A departure from these positions means two different kinds of motion. One denotes a descent, that is, a vertical motion, the other a horizontal movement. Yet we have but one adverb to express these radically different ideas.[27] The original and still the more common force of 'ab' is that denoting a motion 'away from' or 'a separation', and these meanings it still preserves as an adverb in modern German, the preposition 'ab' having disappeared from the language. In view of the very common use of 'heran' and 'hinan' it is strange that a motion in an opposite direction should not have developed parallel forms 'herab' and 'hinab', but this has not been done, 'herab' and 'hinab' being reserved to intensify the more unusual meaning of 'ab', namely, that denoting descent, the opposite of 'auf', 'herauf', etc.

[27] English 'off' represents the same two meanings, *e. g.*, "he got off his horse" = 'he descended from his horse', while "they had driven off before we arrived" = 'they had driven away'. In present day English 'off' usually refers to a departure from a superior surface, or an idea of descent is implied. In colloquial speech a pleonastic preposition 'of' has been added to indicate a point from which the departure is taken.

Part I.

'Ab' with its Original Force

In view of the two distinct meanings of 'ab', it will be necessary to divide Part I of this chapter into two subdivisions.

A. will treat 'ab' denoting horizontal motion;

B. will take up the vertical motion of the same particle.

It is the first of these functions that has undergone the greatest semantic change.

A.

§ 76. In Indo-Germanic times 'ab' (< *apo) meant 'away from'. It has retained this function even in New High German. Sometimes the point of departure is expressed in the form of a prepositional phrase introduced by 'von'. Such is the case in the first of the following quotations from Old High German and Middle High German. In the other quotations the point of origin is not stated. In all of them the idea is one of departure from a position in close proximity to an object, to one farther away. Sentences with a figurative meaning follow those with concrete force.

Tatian (9th C.): inti gioffanôt uurdun irô ougûn, inti forstuontun inan, inti her *abfuor* fon irô ougôn (228, 4).

Nibelungenlied (12th C.): Gunther . . . *gie* von den sciffen *abe* (586, 2).

Wolfram v. Eschenbach (13th C.):

dô *leite* in mit zühten *abe*
Anfortas von dem gewerbe (Parz. 819, 14).

Der Winsbecke (13th C.): durch dîne tugent des *helf* mir *abe* (M).

Das alte Passional (13th C.): dô quam ein widerkraft vil starc und begonn sie *abe trîben* (M.).

Die Stadrechte v. Brünn aus d. 13ten u. 14ten Jh.: den käufer von erbgütern *abtreiben* (M.).

Das Leben d. hl. Ludwig (14th C.): also *sitzen* si *abe* vom lande (M.).

Die Jagd Hadamars v. Laber (14th C.): wil der hunt nâch allen verten balde *ab stozen* (M.).

Vom Herkommen der Schwyzer (15th C.): . . . und warent si also notigen mit sömlicher not, dass si begondent *abziechen* (191, 4).

FIGURATIVE

Nibelungenlied (12th C.): des willen in ir herzen ***kom*** si vil selten *abe* (1396, 1).

Hartmann v. Aue (12th C.):

sô tuo ouch under wîlen schîn
ob er noch riters muot habe.
und *entuo* sich des niht *abe* (Iwein 2856).

Gottfried v. Strassburg (13th C.):

hier über suochte er ir aller rât,
den zwîfel umbe ir missetât,
wie er den sô hin *getæte,*
als er es êre hæte,
eintweder *abe* oder *an* (Trist. 15301).

Das alte Passional (13th C.): des glouben zwîfels schîme begonde ime *abe slîfen* (M.).

wolt ir mir des *abe treten* ('darin von mir abweichen', M.).

Nicolaus v. Jeroschin (14th C.): dô si zum andrin mâle wârn dem geloubin *abgevarn* ('vom Glauben abgefallen', M.).

daz ros ze mittem satel *abe* (Iwein 1114).
ez (das Falltor) *sluoc,* als ich vernomen habe,

§ 77. The Old High German particle gives privative force to the verb. This force is very closely related to the above, the difference being that in the above section one thing departs from another by means of a verb of motion, while in this section something is detached from a person or object. The original relation of the two objects was a closer one than that implied in the preceding section. The verbs of the compounds are not necessarily verbs of motion, but rather verbs of separation which denote the manner of the process.

Tatian (9th C.): *ababrâchun* hungerentê sînê iungiron thiu ehir inti âzun (68, 1).

inti oba thîn zesuuuâ hant thih bisuîhhe, *hou* sie *aba* inti uuirph sia fon thir (28, 3).

oba thîn hant odo thîn fuoz bisuuiche thih, *abasnît* inan inti aruuirf fon thir (95, 4).

Deutsche Gedichte d. 11ten u. 12ten Jh.: mach ich den chunig uberwinden, daz ich dem die chrône *abe ziehe* (M.).

Ludwig d. Frommen Kreuzfahrt (12th C.): sînen bart *abe geschorn* (M.).

Hartmann v. Aue (12th C.):

ez (das Falltor) *sluoc,* als ich vernomen habe,
daz ros ze mittem satel *abe* (Iwein 1114).

Sprachdenkmäler d. 12ten Jh.: sô *bizzet* er ir daz houbet *abe* (M.).

Walther v. d. Vogelweide (12th C.): starken liuten *waet* erz houbet *abe* (DWb.).

Gottfried v. Strassburg (13th C.):

er valte ime ouch bürge unde stete
und *brach* im underwîlen *abe*
sîne liute und sîne habe (Trist. 372).

Wolfdietrich (13th C.): daz houbet man im *abe schôz* (1071, 2).

Wolfram v. Eschenbach (13th C.):

'war zuo ist diz guot, (der Ringpanzer)
ine mag es niht *abe gezwicken*' (Parz. 124, 4).

Berthold v. Regensburg (13th C.): daz er den hals *abe stôzet* oder *vellet* (M.).

Ulrich v. d. Türlein (13th C.): eim schiltknechte wart lîhtê ein spor hie zu hove *abe getreten* (DWb.).

Konrad v. Würzburg (13th C.): mit dem labe daz vil maneger schüzzel *abe* wart *gespuolt* (M.).

daz *weschet abe* der brunne klar (M.).

Nicolaus v. Strassburg (14th C.): den hals *ab vallen* (Deut. Myst. 1, 295, 16).

Peter Suchenwirt (14th C.): der veinde spitz *abreiten* (M.).

Geo. Rollenhagen (16th C.):

Dasz ihm ein Groschen trag der Scherf,
Die Bratwurst ein Speckseit *abwerf* (S.).

B.

§ 78. As stated in the introduction to this chapter, one class of compounds with 'ab' denotes a descent from the top surface of an object. These are the verbs in which New High German usually substitutes 'herab' or 'hinab' for older 'ab', altho 'ab' with its old force is still an active prefix. In several of the following quotations the meanings 'down from' and 'away from' are so closely blended that it is difficult to determine which force is the more prominent in the mind of the speaker.

Genesis (11th C.): *abe wielz* er den stein (M.).

Der Kahle Ritter (13th C.): unz im daz hiubel *abe* swanc, daz ime daz houbet beleip (M.).

Die gute Frau (13th C.): si *reichet* von den sternen *abe* (M.).

Wolfram v. Eschenbach (13th C.):

sus kom unser toerscher knabe
geriten einer halden *abe* (Parz. 138, 10).

Ulrich v. Zatzikoven (13th C.): bêde *wurfen* si sich *abe* ('von den rossen', M.).

Weisthümer (14th C.): den reiter vom pferde *abstoszen* (M.).

Suchenwirt (14th C.): die piderben helt die *vielen ab* ('sassen ab', M.).

Stretlinger Chronik (15th C.): do si nû also trank, do beducht die tochter, wie ir ein brunnender brand durch ir kelen *abgienge* (55, 18).

Fastnachtspiele (15th C.): dasz in die zeher die packen *ablaufen* (267, 21).

lasz *absincken* euren zorn (77, 31).

§ 79. The particle with the force shown in the section just preceding is still commonly used in the expression 'auf und ab'. That a downward motion is here denoted is clear from the contrast indicated by the adverb 'auf'. Such fossilized formulas containing two words with contrasting ideas are common to the language. (Cf. 'aus und ein', § 3.)

Wolfram v. Eschenbach (13th C.):

welt ir und die muoter mîn
mir teilen iwer varnde habe
sô *stîge* ich *ûf* und ninder *abe* ('ascend a high position', Parz. 9, 22).

Hugo v. Trimberg (14th C.): *slæt* daz korn *ûf, slæt* ez *abe* (M.).

Heinrich der Teichner (14th C.): alle stîg die da *vuerent ûf* und *abe* (M.).

Vom Herkommen der Schwyzer (15th C.): das ist als vil, als von der sunnen *ufgang* unz zû der sunnen *abgang* (196, 12).

Goethe (18th C.): *Schweben auf, schweben ab* (12, 236).

Wieland (18th C.): An dem Arm sanft *auf* und *abstreichen* (S.).

Er wurde durch den Schwall der aufgebrachten Wogen lang *auf* und *abgewälzt* (S.).

Rückert (19th C.): Sein Auge *lief* an mir *ab* und *empor* (S.).

SPECIALIZED MEANINGS

Goethe (18th C.): Das immer wiederholte *Ab-* und *Aufschlagen* des Lagers (6, 108).[28]

Wieland (18th C.): Sie (die Bücherrolle) *auf* und *abrollen* (S.).

In the following quotations both 'auf' and 'ab' have lost their original force. In the first two the thought is of an 'up and down' in volume

[28] Cf. specialized meaning of 'auf', § 120, and of 'ab', § 86.

of light and speech respectively, while the last two have lost all idea of an upward or downward motion, meaning merely back and forth.

Walther v. d. Vogelweide (12th C.): der schîn *nimt* drâte *ûf* unt *abe* (M.).

Heinrich der Teichner (14th C.): der niur stille geswigen kund und liez *reden ûf* und *abe,* ez gerou in nimmer sit (M.).

Kohl (19th C.): Thäler, in denen die Menschheit *auf-* und *abflutete* (S.).

Sealsfield (19th C.): Als er . . . halbrasend *auf-* und *abtobte* (S.).

Wilbrandt (20th C.): [er trat] auf den Gang hinaus und *schritt* hier eine Zeitlang, ohne anzuhalten *auf* und *ab* (Osterinsel 282).

Part II.

New Meanings Developed by 'Ab'

§ 80. In this Part the developments of the several concrete meanings of the particle 'ab' will be traced chronologically. There are three functions of the particle which have developed specialized meanings. All three of them existed in Old High German and, as seen in Part I of this chapter, were:

1). to denote a departure from an object;

2). a privative force, *i.e.*, a separation or detachment from an object;

3). to denote the descent from the top surface of an object.

The last of these meanings represents a limited action and does not lend itself freely to semantic development which always presupposes a weakening of a conception originally possessed by a word. The other two old meanings, however, have acquired a number of functions not originally belonging to the adverb or preposition.

§ 81. One of the earliest specializations of the prefix 'ab' was that referring to a removal of clothes from the body and to figures derived from this activity.

Wolfram v. Eschenbach (13th C.): wie *bringe* ichz [daz harnasch] *ab* im unde an mich (Parz. 156, 17).

Das alte Passional (13th C.): [sie] heten *ab* im *gezert* hût, fleisch . . . (M.).

Speculum ecclesiae: daz joch der ubeln herschefte *abe* sime halse *scutte* (M.).

With the last quotation compare the following from Hartmann v. Aue: wan ich *schutte* in [den harnasch] *abe* und gie dan (Iwein 779).

A comparison of these quotations leads us to suspect that in the last sentence we have an elliptic sentence to deal with, an original object of the preposition 'ab' having been dropped. Such an object, even a whole phrase is frequently omitted when the situation makes the meaning clear.[29] Further examples of this use of the particle in a compound follow.

Gedichte des 11. und 12. Jh.: den balc *abe straufen* (DWb.).

Reinhart Fuchs (12th C.): daz heize wazzer *fuort* im *abe* hut unde har (M.).

Physiologus (12th C.): sô suochet siu einen locherohten stein, sliufet dar durch unde *streifet* die hûd *abo* (DWb.).

Hartmann v. Aue (12th C.):

er brach sîne site und sîne zucht
und *zart abe* sîn gewant (Iwein 3235).

ir rouwigen hende hâten daz gebende unschone *abe gestroufet* (Erec 5321).

Wolfram v. Eschenbach (13th C.): der wâppen *teter* sich dô *abe* (Parz. 92, 14).

si *want* mit ir hende
wider *ab* ir houbtgebende (Parz. 780, 8).
ouch *zôch* im mêr gewandes *abe*
manec wol geborner knabe (Parz. 243, 17).

Das alte Passional (13th C.): er sach si ir gebende *rîzen abe* (M.).

einem êre unde guot *abe strîchen* (M.).

Heinrich v. Meissen (14th C.): dô mir der angeborne nebel geistlich wart *abgestrichen* (M.).

§ 82. During the Middle High German period, 'ab' prefixed to certain transitive verbs denoted that part of the object of the sentence was 'worn away' by the action of the verb, that is, it is a development of the privative meaning of the adverb. The earliest examples of this force of the particle are in connection with verbs of walking, riding, etc., which cause the wearing away by frequent repetition or long duration.[30]

Nibelungenlied (12th C.): dâ wart von guoten helden vil kleider *ab geriten* von den hôchgemuoten nâch des landes siten (602, 1).

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[29] Cf. "schlagen sie ein" = 'in meine Hand'. The station master calls: "Abfahren!" and everyone understands what is to ride away and from whence. Cf. § 47.

[30] For an identical force of 'aus' see § 11.

Minnesinger (13th C.):

die stîge sint mir *abe getreten,*
die mich dâ leiten hin an dich (M.).

Luther (16th C.): Die Schneiden an den Sensen waren *abgearbeitet* (1 Sam. 13, 21).

Agricola (16th C.): Die Pferde *stehn* ihre Bein *ab* und können hernach niergend fortkommen (DWb.).

Gryphius (17th C.):

Sind diese die, die vor der Zeit
In Purpur, Seid, und Gold geglissen,
Und die, die in Gebrechlichkeit
Umirrten, kahl und *abgerissen*? (DWb.)

Goethe (18th C.): Die durch Kirchengänger *abgetretene* Grabsteine (S.).

Bürger (18th C.):

Was zwischen manchem wilden Haufen
Sich Bullius, der Aldermann,
An Hörnern endlich *abgelaufen,*
Das läuft sein Weib ihm wieder an (DWb.).

Hartmann (19th C.): Nach und nach wurde mein Anzug so *abgeschoben* und schäbig (S.).

Tieck (19th C.): Alle meine jugendlichen Empfindungen erschienen mir schal und *abgestanden* (DWb.).

§ 83. Closely related to the old privative meaning discussed in section 77 is the force of 'ab' shown by the following quotations. In all of these the compound with the prefix 'ab' denotes a gradual decrease of volume of the subject, all the verbs being intransitive. The idea upon which this development is based, is that of a separation of a part from the rest of the subject.

Arzneibuch des 12ten Jh.: die sint guot den, die *abenement* an dem libe (M.).

Walther v. d. Vogelweide (12th C.): er hete an fröiden *abe genomen* (M.).

Gottfried v. Strassburg (13th C.):

(er fürchtete) im solte von dem bluote
an krefte unde an muote
in kurzen zîten *abe gân* (Trist. 16073).

Hans Sachs (16th C.): dir *get ab* an ghör (DWb.).

Friedrich v. Logau (17th C.): Es *fällt* viel *ab* von ihrem Willen (A.).

Opitz (17th C.):

Siehe, wie ich *ab* sei ***kommen,***
Wie mir alle Kraft genommen (C.).

Goethe (18th C.): Der hinein geworfne Stein treibt das Wasser nach allen Seiten, die Wirkung erreicht eine höchste Stufe, sie ***klingt ab*** und gelangt, im Gegensatz, zur Tiefe (52, 57).

Durch die milde Sommerluft war das Gewölbe immer mehr *abgeschmolzen* (S.).

§ 84. A verb compounded with 'ab' may denote that some part of a person or thing has been separated from him or it. But the thing separated from a person need not necessarily be a part of him physically, but may be something possessed by him. The accompaniment of the deprivation, or rather a result of it, may be 'a transfer of the possession' from the original owner to another, the verb denoting the means of transfer. For instance, the removal of an object from a person and its acquisition by another may be the result of force or superiority, which is expressed by the verb. The prefix 'ab' signifies that the original possessor is uppermost in the mind.[81]

Ludwig d. Frommen Kreuzfahrt (12th C.): einem den sige ***abe-slâhen*** (M.).

Hartmann v. Aue (12th C.):

ichn ger niht iuwer habe,
ichn *gewinnes* iu *abe* (Iwein 2608).

Wackernagels Lesebuch: dasz sie grosze Beut . . . uns wolle ***ab-streifen*** (S.).

Fastnachtspiele (15th C.): das du mir mein kind hast ***abgelogen*** (43, 3).

das er mir tut mein pfrunt ***absteln*** (144, 13).

Luther (16th C.): Es müst ein armer Teufel sein, dem die solten eine Seele ***abbeten*** (DWb.).

Nicht zwingen, sondern durch freundliches Ermahnen ***abbitten*** (DWb.).

Solche Vermahnung nehmet für gut, die mir euer Sohn mit groszem Fleisz *abgeflehet* hat (DWb.).

[81] By omitting the object of the preposition, the type is established for sentences such as those discussed in the present section. They may have had their rise in elliptic expressions.

von herzeleid geschah im daz
daz siz (daz vingerlîn) im *ab* der hant *gewan* (Iwein 3199).

For the opposite attitude cf. 'aneignen', etc.

Hans Sachs (16th C.): Meinten die Schanz uns *abzudrengen* (A.).
Den Kaufleuten ir Geld *abschrecken* (DWb.).
Den Himmel uns noch *abzustürmen* (DWb.).

Goethe (18th C.): Einem Gespenste gleich unter den Lebenden bleiben, und mit hohlem Ansehn einen Platz behaupten wollen, den ihm ein anderer *abgeerbt* hat und nun besitzt und genieszt (8, 231).
Die Langeweile *forderte* mir eine mäszige Thätigkeit *ab* (31, 89).
. . . und er *horchte* ihnen ihre bestimmten Kentnisse *ab* (S.).

Wieland (18th C.): *Lockt* keinen Blick durch seinen Scherz ihm *ab* (DWb.).

Bürger (18th C.): Ihr ein Lächeln *abzuzwingen* (DWb.).

Schiller (18th C.):

Wie er räuspert und wie er spuckt,
Das habt ihr ihm glücklich *abgeguckt* (Lager 209).

§ 85. A strongly metaphorical force of the particle is that which gives to the compound the meaning 'to refuse', *i.e.*, turn away from a thing.

Hartmann v. Aue (12th C.):

durch die selben und durch in
dem ich wol schuldec bin
daz ich im nihtes *abe gê*
daz im ze dienste gestê
muoz ich sî under wegen lân (Iwein 4909).

Wolfram v. Eschenbach (13th C.):

mit êren âne schande
wart in geteilet dâ sîn habe,
mit valsche niht *gewîset abe* (Parz. 336, 24).

Livländische Chronik (13th C.): der bete er im niht *abe trat* (M.).

Peter Suchenwirt (14th C.): dem der tôt hât *abgesait* daz leben (M.).

Fastnachtspiele (15th C.): darumb woll wir die heirat *abschlahen* (112, 32).

Luther (16th C.): So doch Gott selbs solchen ungehorsamen Kindern flucht und langes Leben *abspricht* (DWb.).

A refusal and a denial are very closely related, as is shown by the following sentences which constitute a denial, while those above denoted a refusal.

Meister Eckhart (14th C.): swer daz gote wolde *abe sprechen* (Deut. Myst. 2, 151, 40).

Arnim (19th C.): Seine Unterschrift *abschwören* (S.).
Gervinus (19th C.): Es ist thöricht dieser Gesellschaft grosse Einflüsse *abreden* zu wollen (DWb.).

§ 86. A German uses the compound 'aufbauen' to denote the construction of a building. The thought is that of putting one stone upon another or otherwise elevating the structure. The same idea is contained in English: "He is putting up a new house." But, whereas in English the opposite activity is indicated by a verb with the adverb 'down', Germans commonly employ the adverbial particle 'ab' in this sense, tho 'nieder' may also be used. In general, compounds so formed contained an idea of a violent 'taking down' or 'apart' of a structure, as the following quotations will show.

Wolfram v. Eschenbach (13th C.):

der künec Gramoflanz enbôt
ze Rosch Sabbîns den sînen,
si solten sich des pînen
daz se *abe bræchen* bî dem mer (die Zelte)
und vor tage koemn mit sîme her (Parz. 731, 17).

Der Stricker (14th C.): si brennent die burc oder *stôzens abe* (M.).

§ 87. During the Middle High German period, a group of verbs compounded with 'ab' came to denote 'a removal from a position or office'. As faded metaphors they are still active with this force in modern German. The figure is that of some one descending, voluntarily or otherwise, from a throne or other position. The descent from an elevation, physical, social, political, is not any longer felt in all cases, there being chiefly a conception of a removal from such a position now. Thus the old form 'absetzen', and the newer one 'herabsetzen', have quite distinctive meanings, the one to remove, the other to degrade.

Livländische Chronik (13th C.): des amtes er niht *abe trat* (M.).
Urkunden Kaiser Ludwig des Bayern (14th C.): den rât setzen und *ablâzen* (L.).
Zürcher Jahrbuch (15th C.): der rât wart geendrot und entsazt und wurdent die gewaltigen alle *abe gestôzen* (M.).
Monumenta Habsburgica (15th C.): *abstehen* (= 'abtreten von einem Amte', L.).
Luther (16th C.): Er ändert Zeit und Stunde, er *setzt* Könige *ab*, und setzt Könige ein (Dan. 2, 21).
Jason, der seinen Bruder vom Amt *abgestoszen* hatte (DWb.).

§ 88. It has been seen that 'aus' and 'ab' have in several instances developed similar force. Another example of such parallel development is treated in this section, that is, the force 'to put an end to' or 'to stop', according to whether the verbs are transitive or intransitive. As in the case of many other compounds, some particular group of verbs served as a starting point for the semantic change, all of the early compounds having a privative force. In such cases a departure or separation of one thing from another is equal to putting an end to its existence.

Deutsche Predigten des 13ten Jh.: daz got dîn leben *abe snîdet* (M.). The figure is similar to that of Fate cutting off the thread of life, which is equivalent to ending the life.

Die Stadtrechte v. Brünn aus d. 13ten u. 14ten Jh.: (eine Schuld) *abtragen* inner jârs vrist (M.).

Das alte Passional (13th C.): wand im sîn leben *abe trat* = endete (M.).

Nicolaus v. Strassburg (14th C.): der viel in einen zwivel, daz nâch disem lebende nit ein ander leben wêre, und *lie* sine erbarmeherzikeit *abe* und gedâhte (Deut. Myst. I, 265, 30).

Hermann v. Fritzlar (14th C.): aber iz geschach alsô vil bôsheit des nachtes, daz die heilige kristenheit diz (Fest) *abe leite* = 'abschaffen' (Deut. Myst. I, 86, 29).

Peter Suchenwirt (14th C.): dem der tod hat *abgeseit* daz leben (M.).[82]

Jacob Twinger v. Königshofen (14th C.): daz siu soltent die geischeler *abe duon* und verbieten (M.).

Luther (16th C.): Es gerate mit meinen Sprüchen wie es wolle, so viel sie auch den Ablasz *ablegen* (DWb.).

Mathesius (16th C.): So gehts auch in Zechen, das sich oft das Erz verdruckt oder gar *absckneidet* (DWb.).

Goethe (18th C.): Als ein für allemal *abgethan*, abgemacht, und fertig erklärt (S.).

The following have intransitive force.

Theophilus (12th C.): uns er *abe liez* (M.).

Minnesinger (13th C.):

swenne si ir strîten lânt
und die kriege *abe gânt* (M.).

Mai und Beaflor (13th C.): er *nam* niht *abe* von sîner klage (M.).

Luther (16th C.): die Verheiszung *ist ab* (Römer 4, 14).

[82] As seen in § 85, 'absagen' may mean to refuse or deny. In this passage that would be equal to 'to put an end to'.

Closely related to the above meaning, in fact, but another development of it, is the force of 'ab' acquired during late Middle High German times. The particle denotes that an object is 'put out of existence' by means of the action indicated by the verb, while in the preceding list the verb denoted the manner in which the end was brought about as an object (or subject). Frequently in the following list, the verb denotes the expiration of an indebtedness or a credit, that is, rubbing it off the slate.

Weisthümer: Die rechnung beim wirt *abtrinken* (M.).
kann er es *abgebeten*, so darf er es nit abgelten (M.).

Friedrich v. Logau (17th C.): Ob er gleich die Zins *abführt* (DWb.).

Goethe (18th C.): *Bitte* den Göttern *ab* deine Noten über Homer! (S.).

Herder (18th C.):

Fleht tiefgebeugt ihr Alles *ab*
Was sie ihr Leids begunnt (S.).

Alxinger (18th C.):

Ich fühlte tief mein Unrecht und began
Es *abzubüssen*, abzuweinen (S.).

Fichte (18th C.): Sein Geld *abhören* wollen ('von dem Student, der für vorausgezahltes Geld Vorträge hört' (DWb.).

§ 89. By driving stakes or digging a ditch around a piece of land to indicate its limits it is separated from the surrounding territory.[33]

Opitz (17th C.): Doch diese Dunkelheit hat *abgesteckte* Schranken (A.).

Goethe (18th C.): Schon hatte sich das Volk auf die oberwärts *abgestochnen* und vom Rasen entblösten Dämme gedrängt (17, 157).

Usually before thus dividing ground into smaller plots, these are measured; hence, compounds denoting such a division of land came also to acquire the force 'to measure'. One of the earliest methods of measuring was by pacing the distance in various directions.

Goethe (18th C.): Wenn ich sie herumziehen sehe mit losem Haar, im Mondschein einen Kreis *abgehn* (11, 50).

Adelung (18th C.): Einen Weg *abfahren* = durch ein Fuhrwerk abmessen.

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33 Cf. English, 'to stake off', 'to fence off', etc.

Campe (19th C.): Den Platz zum Lager *abreiten* = die Ausdehnung desselben durch Abzählen der Schritte des Pferdes reitend messen.

Abspannen = mit der Spanne, mit ausgestrecktem Daumen und kleinem Finger abmessen.

Altho in the following quotations the idea of measuring has been lost sight of, the underlying thought is the same. The compounds denote that an activity—that is, motion—extends over a certain area.

Olearius (17th C.): Eh dasz faule Schläfer den Kopf nach dem Wege aufrichten, so haben hurtige Gänger ihren Weg schon *abgelegt* (DWb.).

Goethe (18th C.): Oft *sieht* man gar nicht *ab*, wohin das Wasser seinen Ablauf nehmen will (27, 177).

Joh. Gottfr. Seume (18th C.): Wir *schlenderten* eine hübsche Partie *ab* (DWb.).

Adelung (18th C.): Man kann es mit dem nassen Finger *ablaufen*.

Sanders (19th C.): Ich bin danach die ganze Stadt *abgelaufen*.[84]

§ 90. Beside denoting that an end has been put to something, or something has stopped existing, 'ab' may indicate that point of an operation at which the activity is concluded.

Fastnachtspiele (15th C.): lasz ichsz gar gutlich *abgen* (166, 16).

Sebastian Frank (16th C.): Wann das Wepp des Lebens die Parcen haben *abgewirkt* (DWb.).

Goethe (18th C.): Wo der Jugend ein gewisser Zwischenraum gegönnt war, in welchem sie sich *abtoben* möchte (43, 327).

Göckingk (18th C.):

Mein Tagewerk ist noch nicht ganz geendet
Lasz mich geschwind noch *ab* es *thun* (DWb.).

Joh. Gottfr. Seume (18th C.): Ich *machte* die fünf Meilen recht stattlich *ab* (C.).

Ich *tanzte* die Verse *ab* (S.).

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[84] In the sentence, "Wir wollen es *absehen*" ('absehen' = 'wait and see'), we obtain a certain knowledge as a result of the action of the verb. 'Ab' has a similar force in 'abhören', 'abwarten', etc. Cf. the following:

Luther: Dabei ist *abzunehmen*, was für licht in der Archa gewesen sei (DWb).

Döbel: Leget man sich auf den Boden und höret den rechten Ort *ab*, wo die Hunde vorliegen (S.).

Hans Wilh. Kirchhof: Der Feind vornemmen und Gelegenheit des Orts zu erfahren und *abzuschauen* (DWb.).

Moser: *Warten* Sie es nur *ab* (Bibliothekar I, 1).

Höfer: Knechte sollten die Umgegend *abstreifen* (S.).

Klamer Schmidt (18th C.):

Auf der verhängnisvollen Spindel
Läuft Wilhelms Faden *ab* (S.).

H. v. Kleist (19th C.): Bis das Gigantenjahr des Platon *abgerollt* (S.).

§ 91. In the metonymic expression, "Ich *schreibe* den Brief *ab*," 'ab' indicates that something is written off the letter, as from a source. All of the following compounds with 'ab' express a similar idea.

Closener (14th C.): wer die botschaft *abe schribet* (M.).

Keisersberg (15th C.): Heidnisch werk, wenn das eigentlich nach seinem Bildner *abgewirkt* wird (S.).

Luther (16th C.): Das ich sie bisher nicht recht und genug gemahlet habe, sondern allein auf ein Papier schlecht *abgerissen* (DWb.).

Goethe (18th C.): Da wird ein Todter geschwind noch *abgegossen* . . . und das heiszt man eine Büste (17, 206).

In dem die zu Weimar befindlichen Durchzeichnungen von diesen Kopien *abgenommen* sind (S.).

§ 92. The force 'to tire out', is developed from the meaning 'to wear out' noted in section 82. In the latter section (82) the object was inanimate, while the objects in the following quotations are animate beings. It will be seen that all of the sentences are metonymic, for it is not the object which is removed; on the contrary, this remains after some unnamed quality has been removed from it. It may further be added that a majority of the verbs in this section are reflexive.

Leos v. Roszmital Reise (15th C.): es machet *abgerittne* Pferd, müd Leut (M.).

Luther (16th C.): Hui Bock, sei zornig und stosz mich einmal, hol aber nicht zu weit aus, dasz du dich nicht *ablaufest* (DWb.).

Zinkgräf (17th C.): Etliche *abgeführte* [abgetriebene] Klosteresel zu Mark zu führen (S.).

Grimmelshausen (17th C.): Simplicius wolte die Wirthin sich nicht mehr so *abnöthigen* lassen (DWb.).

Goethe (18th C.): Ich *arbeite* mich *ab* (2, 93).

Sich um der Gunst des Tags Willen *abzuhetzen* bringt keinen Vortheil für morgen und übermorgen (49, 137).

Bei Gott! wenn ich mich nicht *abritte* und *abarbeitete*, wir wären noch auf dem alten Flecke (57, 152).

Du bist schon wieder *abgetrieben* (11, 144).

§ 93. As early as late Middle High German 'ab' was prefixed to verbs denoting 'to die', 'to kill'. The idea added by the particle is that of 'off', 'away'. It is the same thought which is contained in English—'to depart', 'pass away' from this life, from among us. As will be seen from the following list of quotations, 'ab' is prefixed to verbs which by themselves express the idea of killing or dying, hence the prefix does little more than intensify the thought already contained in the verb.

Zürcher Jahrbuch (15th C.): diu edlen geschlecht von grâven, hêrren diu alle vertriben und *ab gestorben* sind (M.).

Luther (16th C.): Wenn mann im ein hundert tausend. Man *abschlüge,* so ist er bald wider da mit so viel Man (DWb.).

Wickram (16th C.): Damit sie des guten *abgestorben* Kerls desto ehe vergessen möchten (DWb.).

Hohberg (17th C.): Die verpflanzten Beischosz leichtlich *abstehn* (DWb.).

§ 94. As seen in the preceding section, 'ab' need add no new thought to the simple verb. The following list contains additional verbs to which 'ab' without any functional value is prefixed. At most it intensifies the idea already contained in the verb.

Luther (16th C.): Inen dürre *absagen,* das sie von solcher Prophezei *abliesszen* (DWb.).

So ist's kurzum *abgesagt* mit dem Spruch, das wir alle sterben müssen (DWb.).

Grimmelshausen (17th C.): Als es leider heutzutag dergleichen Kerle genug *abgebet* (DWb.).

Goethe (18th C.): Der Leibschneider, der seine Meinung *abgeben* musste (S.).

Wieland (18th C.): *Abprügeln* (= 'derb prügeln', DWb.).

Gessner (18th C.): Bei so sehr *abgeänderten* Sitten (DWb.).

Schiller (18th C.): Vom Schiff es springend *abzuerreichen* (DWb.).

Müller-Guttenbrunn (20th C.): Die grossen Buben haben das Vieh *abzufüttern,* ehe auch sie das Haus verlassen (Glocken 195).

In the following sentences the compounds with the prefix 'ab' denote 'to descend from'. The prefix points to a source, but since this is generally added in the form of a prepositional phrase, and since the simple verbs contain the force 'to descend', the prefix adds no new thought to the sentences.

Friedrich v. Logau (17th C.): Dasz von Kunst künstlich, können *abfliesze* (DWb.).

Hahn (18th C.): Irrthum derjenigen, die ihn von den schwäbischen Herzögen *abführen* (DWb.).

Bürger (18th C.): Aus diesem Samen *sprang* Diokles *ab* (S.).

§ 95. A number of verbs compounded with 'ab' refer to shooting or discharging a gun. Obviously these sentences are metonymic. The use of 'ab' in this connection instead of some other prefix, for example 'aus', would be easier to explain if its use could be shown to antedate the invention of gunpowder and the use of firearms. We might expect the particle 'ab' to refer to the departure of a bolt from a cross-bow but it hardly expresses the idea of a bullet leaving a gun.

Ayrer (16th C.): Hört wie man zur Freud *abgehen* lässt die Geschosz (DWb.).

Opitz (17th C.):

Wann dein Bogen wird von dir *abgezogen*,
Machst du sehen die andern Winden? (DWb.)

Iffland (18th C.): Auf einen *abschieszen* (DWb.).

Campe (19th C.): Alle Kanonen *prasseln* auf einmal *ab*.
Der Pfeil *schwirrt ab* durch die Luft.

Grimm (19th C.): Er *knallte* seine Flinte *ab* (DWb.).

§ 96. In the case of a few compounds, 'ab' seems to denote the 'acquisition of proficiency'. This force is probably developed from the meaning treated in § 90, denoting an action carried to completeness. The following is a representative list of compounds having this force.

Jesuitencomödie (17th C.): Ein Schuster hatte ein sehr bösen, in allerhand Bosheit *abgeführten* Buben (DWb.).

Hohberg (17th C.); Sperber, Falken, Habicht *abtragen* soll man im August (DWb.).

Adelung (18th C.): Ein Pferd *abreiten*, es nach der Kunst zureiten.

Müller-Guttenbrunn (20th C.): Dort hat mich der Lajos *abrichten* lassen (Glocken 67).

§ 97. 'Ab' may also give to the compound the idea of contrast. In section 89 'abstechen', etc., were shown to mean 'to set aside', *e. g.*, a piece of ground from the surrounding land. A ditch around it might set it off, *i. e.*, point out to whom it might concern that this particular piece of ground had a somewhat different status from the adjoining land. Already the idea of 'setting off', 'contrasting', is present. This is more or less emphasized by the situation described, as will be

seen from the following quotations. The 'setting apart' in this group is not brought about by means of the action implied by the verb, but as a result of qualities possessed by the objects themselves.

Brockes (18th C.):

Sticht ein beschattet Grün
Recht angenehm sich *ab* (DWb.).

Campe (19th C.): Diese . . . *schnitten* scharf dagegen *ab*.

Tieck (19th C.): Die singenden Mädchen *hoben* sich gegen den düstern Tannengrund allerliebst *ab* (DWb.).

Gutzkow (19th C.): Etwas *springt* gegen etwas *ab* (S.).

§ 98. When we say, "Er spielte einige Stücke auf dem Klavier ab," 'ab' means that he played them thru, but it may also imply that he played them 'off' from the notes; that is to say, 'ab' refers to a source which is not named, in fact we scarcely feel the presence of such a source, so accustomed have we become to these compounds with their specialized meanings. (Cf. § 91.)

Goethe (18th C.): Die Litanei demütig *abzubeten* (31, 37).

J. H. Voss (18th C.): Eine Sonat' *abbrausend* ('rauschend abspielen', S.).

Campe (19th C.): Der Prediger *orgelt* seine Rede *ab*.
Der Papst *schmettert* einen Bannfluch nach dem andern *ab*.

Part III.

'Herab' and 'Hinab' with their Original Force

§ 99. As stated at the beginning of this chapter, 'ab' as an adverb denoted a direction opposite to that indicated by 'auf' or 'an'. The original function was to denote a direction away from an object. This is still the more usual to this day. The particles 'her' or 'hin', however, are prefixed almost exclusively to 'ab' with its secondary meaning, 'to descend'.

Genesis und Exodus (12th C.):

der gelust si des bedwanch
daz si einz (obst) *her abe swanch* (M.).

Minnesinger (12th C.):

der vîol stuont ûf einer stangen,
her Nîthart tet in *herab langen* (M.).

Hartmann v. Aue (12th C.):

ez *hanget* von einem aste
von golde ein becke *her abe* (Iwein 587).
(der Löwe lief den Riesen an)
und *zarte* im cleit und brât
als lanc sô der rüke gât
von den ahseln *her abe* (Iwein 5055).

Minnesinger (13th C.): île und *kum her abe* (M.).

Rudolf v. Steinach (13th C.): *triuc* mich nicht *her abe* (M.).

Boner (14th C.): er *gieng her ab* balde unde sprach (DWb.).

Hermann v. Fritzlar (14th C.): dô *ginc* her *her abe* durch di bôsheit des volkes (Deut. Myst. 1, 167, 10).

Nicolaus v. Jeroschin (14th C.): von der vestin sich *herab machte* brûdir Conrât Swâb (M.).

dô er sich *her abe* mit dem roube *wante* die diet in überrante ûz derselben gegenôt (M.).

Zimmerische Chronik (14th C.): der jonfer den girtel under die knie *heraff spannen* (M.).

Stretlinger Chronik (15th C.): do zerbrach der strik und *viel* also hoch *harab* von dem galgen (120, 6).

do ward der richter gebeten von sinen fründen, dass si in möchtent *harab nemen* und begraben und bestatten (54, 15).

der herr war bewegt zů erbarmherzigkeit und *gieng harab* von sinem pferd und kusste in (20, 13).

und *trat harab* von sinem pferd und nam in in sin arm (20, 2).

The following Middle High German quotations contain verbs compounded with 'hinab'. Of these there are seven.

Wolfram v. Eschenbach (13th C.):

er traf in dâ man hæht den schilt,
daz von Munsalvæsche der templeis
von dem orse in eine halden *reis,*
sô verr *hin ab* (diu was sô tief),
daz dâ sîn leger wênec slief (Parz. 444, 25).

Das alte Passional (13th C.): die heten sich nu ûz genumen und *giengen* heimlich *hin abe* (M.).

si sâhen nider in dem grabe, wie Laurentius *hin abe ruckte* (M.).

ir schif *sigelte hin ab* (M.).

Nicolaus v. Jeroschin (14th C.): sich *hinab machin* (M.).

er las ûz wol sechzic man und mit den *hin abe trat,* verholnlich an ein stat (M.).

Stretlinger Chronik (15th C.): und alsbald in der henker *hinab liess* an dem strick, do zerbrach der strik (120, 5).

§ 100. The prefixes 'aus' and 'ein' were found to have added the demonstrative particle 'her' and 'hin' to give additional force to the simple prefix as early as the Old High German period. The double prefixes 'herab' and 'hinab' do not occur until during Middle High German times. The emphasis in all of the examples in § 99 is on a motion downward toward, or away from the speaker. The point of departure denoting the base or origin, is frequently added as a complement to the verb.

A growth similar to 'heraus', 'herein', etc., may be noted for 'herab' and 'hinab'. By the end of the 14th century the number of compounds with the latter prefixes was almost twice as large as that of verbs compounded with either 'heraus' or 'herein', etc., but since the New High German period the spread of all of the double prefixes has been nearly parallel.

STATISTICS ON THE SPREAD OF 'HERAB' AND 'HINAB'

	'HERAB'	'HINAB'	TOTAL
Old High German period	—	—	—
Middle High German period	15	7	22
Luther	17	13	30
Rest of 16th Century	6	5	11
17th Century	14	8	22
Goethe	11	14	25
Rest of 18th Century	64	37	101
Campe	69 (10)	79 (17)	148
19th Century	9	11	20
	205	174	379

§ 101. Often a noun in the accusative denotes the surface over which a motion indicated by a verb is taking place.

Wieland (18th C.): *Tränen* rollen die Wangen *herab* (DWb.).

Göckingk (18th C.):

Ungern *schleichen* wir den Weg
Unsers Lebens bis zum Grab *herab* (DWb.).

PART IV.

NEW MEANINGS ACQUIRED BY 'HERAB' AND 'HINAB'

§ 102. Just as the simple particle 'ab' has not undergone as great changes as have 'aus' or 'ein', its original force being in general still transparent (cf. §§ 80–98), so the double prefixes 'herab' and 'hinab' show less tendency to semantic development than the double prefixes treated in earlier chapters.

Altho 'her' or 'hin' is regularly added to the prefix 'ab' only when it expresses the idea of a motion downward, they may be prefixed to 'ab' when the latter has a privative force. In fact, the few instances of semantic change of 'herab' and 'hinab' are developments of the privative force of the particle which is thus intensified.

§ 103. In the following sentence from Wolfram von Eschenbach, 'ab' does not indicate a downward motion, but a separation. 'Hin' must be considered from the standpoint of the object from which the separation is made, rather than with reference to the speaker.

Wolfram v. Eschenbach (13th C.):

Gâwân sich zuckes werte;
ein bein *hin ab* er im *swanc* (Parz. 571, 29).

J. H. Voss (18th C.): Ob die Furch' in einem Zug' ich ***hinabschnitt*** (S.).

§ 104. 'Herab' may develop a force almost identical with that discussed in the preceding section. Like 'hinab' it is merely an intensive form of 'ab'.

Stieler (17th C.): ***herab trennen*** = demetere, desecare, etc. (DWb.).

Goethe (18th C.):

. . . die Thürme schwanken,
Gefugte Steine ***lösen*** sich ***herab*** (9, 378).

Wieland (18th C.): Solche Brocken von der ersten besten Leichenpredigt ***herabzuschneiden*** (S.).

Campe (19th C.): Es ***geht*** nicht ***herab*** = kann nicht abgesondert werden.

§ 105. Hermann v. Fritzlar says: dî hunde schrieten sêre und hûleten, und di jegere di wunderten sich sêre und ***zugen her abe*** = 'stellten die Jagd ein'.[85] In modern German we should say "zogen ab," and this also was the usual compound for Middle High German, but the

[85] *Deut. Myst.* I, 193, 22.

addition of 'her' seemed stronger to the mystic who was not famous for his simplicity of expression.

§ 106. The force of 'ab' treated in section 98, meaning to 'sing off', etc., has been intensified by the addition of 'her' in a few instances without making the figure any clearer or much more forceful.

Goethe (18th C.): Wenn man seine Perioden nicht nach der hergebrachten Weise *heraborgelte* (14, 74, S.).

Auerbach (19th C.): Mit Behaglichkeit hatte der Vorsänger seine Gesänge *herabgeleiert* (S.).

Grimm (19th C.): eine Melodie, eine Symphonie *herabspielen* (DWb.).

§ 107. In section 90 occurred the figure of Parcae spinning the thread of Fate to an end. In that case the compound 'abspinnen' denoted the continued spinning until fate had been fulfilled. Goethe uses 'herabspinnen' with almost identical force.

Goethe (18th C.): Dasz ich diese (Welt) noch lange, von dir beleuchtet, erblicke, *spinne* die Parze mir klug langsam den Faden *herab* (1, 283).

Goethe does not intend to express any idea of a downward motion, nor of an approach toward the speaker. In the preceding chapters it was shown that Goethe was very free with the use of 'her' and 'hin' as prefixes to verbs compounded with 'aus' and 'ein'. The demonstrative particle in most cases added a force no longer possessed by the old compound. Goethe with his keen feeling for the subtleties of language, realized the difference and employed the newer form whenever he saw fit, not being deterred by traditional forms and expressions. It need not surprise us to find an occasional use of such expanded prefixes in places where, to us, they do not seem to be required. The following citation from Campe is self-explanatory.

Die Seite *herabsingen* = die Seite bis unten zu Ende singen.

§ 108. One of the figurative meanings of verbs compounded with 'ab' is 'to descend' (abstammen). 'Hinab' has a like use.

Herder (18th C.): Die älteste, durch hundert Profeten *hinabgeerbte* Religion der Welt! (C.)

Schiller (18th C.):

Wo die Kränze des Ruhmes hängen
Und das goldne Zepter in stetiger Reihe
Wandert vom Ahnherrn zum Enkel *hinab* (C.).

§ 109. Finally there are a few verbs compounded with 'herab' which have acquired a specialized meaning, being employed as technical terms.

Herder (18th C.): Sie (die Gebirge) scheinen gleichsam der alte Kern und die Strebefeiler der Erde zu sein, auf welche Wasser und Luft nur ihre Last ablegen, bis endlich eine Pflanzstätte der Organisation ***herabgedacht*** und geebnet ward (DWb.).

Campe (19th C.): In der Pflanzenlehre heisst ein Stengel herabgebogen wenn die Äste desselben in einem Bogen ***herabhangen.***

In der Pflanzenlehre heisst ein sitzendes Blatt ***herablaufend*** wenn es mit seinem blättrichten Wesen am Stengel noch fortgehet.

SUMMARY

§ 110. Below is a summary of Chapter III.

1). Originally 'ab' was an adverb of direction denoting a departure from somewhere.

2). A prepositional function was acquired which was again lost during the early New High German period.

3). The departure indicated by 'ab' might be taken from the top surface of an object, thus giving to 'ab' the connotation downward. This was a secondary development.

4). Specialization and semantic change was noted as early as the 12th century. The development in nearly all cases was based on the original force of 'ab' denoting 'separation'.

5). While the particles 'aus' and 'ein' were aided in maintaining their old function by the prepositions 'aus' and 'in', 'ab' had no such support after the loss of the preposition 'ab'. Some other word is now used to express the horizontal motion formerly denoted by 'ab'.

6). 'Her' and 'hin' are prefixed to 'ab' to intensify it in its secondary function, namely, indicating a downward direction. It is first recorded during Middle High German times. The spread of the double prefix is rapid since the New High German period.

7). 'Herab' or 'hinab' are sometimes substituted for 'ab' in the specialized uses of the latter. In these cases they do not indicate a direction relating to the speaker, but merely intensify the simple prefix.

8). After deducting Campe's coinages, there are nearly twice as many verbs compounded with 'herab' as with 'hinab'.

CHAPTER IV.

AUF, HERAUF, HINAUF

§ 111. Like the other particles thus far treated, 'auf' originally was an adverb denoting direction. It was more general in its meaning than 'aus' or 'ein', in that no source or goal was indicated, but merely the direction upward. The adverb acquired the meaning 'upon', that is, on the superior surface of an object, only after the development of the preposition, not much before the Old High German period.[86] This development was probably the result of the ellipsis of a prepositional phrase with 'ûf'. Before the ellipsis, the particle 'ûf' indicated only the direction of the motion, while the preposition named the goal.

Part I.

'Auf' with its Original Force

§ 112. Altho many compounds with 'auf' still retain the original force of the prefix, there is a large number of verbs compounded with this particle in the older language, which now require one of the double prefixes 'herauf' or 'hinauf' to express the same idea.

Muspilli (9th C.):

. . . die dâr fona himile quemant,
die *pringent* sia sâr *ûf* in himilo rîhi (Braune-Leseb. 30, 13).

Otfried (9th C.): thes krûces horn thâr obana, thaz *zeigôt ûf* in himila (5, 1, 19).

Tatian (9th C.): inti oba iz (d. Schaf) bifellet in Sambaztage in gruobe, nibi her neme inti iz *ûfheue?* (69, 6.)

uar zi themo sêuue inti uuirf thînan angul inti then fisg thie dâr êrist *ûf quimit* nim inti giofnôtomo sînemo munde fintis scaz (93, 3).

Nupties Marcurii et Philologiae (10th-11th C.): *fûorta ûf* (in daz hertuom) (G.).

Psalm (11th C.): *far* ih *uf* ze himile (G.).

Deut. Gedichte d. 11ten u. 12ten Jh.: daz si den berc *ûf cherten* (M.).

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[86] 'An' was still the usual preposition denoting the relation 'upon'.

Hartmann v. Aue (12th C.): sam si (d. Vögel) *ûf* zen lüften *swebten* (M.).

Minnesinger (13th C.): daz ir schal *ûf* durch diu wolken *dringet* (M.).

Lobgesang (13th C.):

du (Maria) bist diu barmherzkeit
diu hôhe *ûf* in den himel *treit* (M.).

Gottfried v. Strassburg (13th C.):

diu hôhe deist der hôhe muot,
der sich *ûf* in diu wolken *tuot* (Trist. 16944).

Heinrich v. d. Türlein (13th C.): ein gebirge ungehiure *steic* er *ûf* in ein ander lant (M.).

Rudolf v. Ems (13th C.): daz wazzer in den munt *ûf werfen* mit der hant (L.).

Das alte Passional (13th C.): ein stanc der *ûf* ûzer pfutzen *swanc* (M.).

Konrad v. Megenberg (14th C.): wenn der pfau hôch *auf klimmet* (L.).

Düringische Chronik (15th C.): die slûgen daz vihe an vor Isenache und *trebin* daz die Horsil *ûf* (M.).

It will be noted that the conception in all of the compounds is that of a motion upward, frequently toward a goal, but this goal is not the top surface of an object.

Wolfram v. Eschenbach (13th C.): Gâwân *reit ûf* an den berc (Parz. 352, 2).

'Uf' still retains its original force, denoting an upward motion, while the goal, namely the upper surface of the hill, is expressed by the prepositional phrase 'an den berc'.

The following quotations from New High German writers contain examples of verbs compounded with 'auf', which are customarily compounded with one of the double prefixes 'herauf' or 'hinauf'. But since many of these verbs have come down from a period when 'auf' still possessed its old function, they still have a force identical to forms with 'herauf' and 'hinauf'. The simple prefix with the old force is not found in new formations, however.

Joh. Fischart (16th C.): Aus der feisten Kuchen *aufdringen* (DWb.).

spintisiert, wie die Mück die Wand *auf laufen* (DWb.).

Kirchhof (16th C.): Hohe Mawren, Wäll *aufklimmen* (DWb.).

Opitz (17th C.): nachdem Messias war zum Vater *aufgereist* (DWb.).

Stieler (17th C.): Steine, Holz ***auflangen*** (DWb.).

Goethe (18th C.): Uns anzuziehen und in edlere Regionen ***aufzulocken*** (S.).

J. H. Voss (18th C.): Wie ein Fischer . . . die zappelnde Beute ***aufschwenkt*** an das Ufer (DWb.).

Alxinger (18th C.): (Der Ritter) ***ruft*** zu Flandrinen ***auf***: Seid ruhig! (S.).

Fr. Müller (18th C.): Wenn einst die Seele ***aufwandelt*** über die Sternenbahn (S.).

Bacchus zogst sie dann hoch ***auf,*** dass sie herabkreisen von deinem Weingelände (DWb.).

Lenau (19th C.):

> Die Seele ***hastet*** was sie kann,
> *Auf* nach des Berges steilen Zinnen (S.).

Sanders (19th C.): Er ist den Berg ***aufgejagt.***

Wilbrandt (19th C.): Auch den dunkelsten (Grund) an das heilige Licht ***aufzuzerren*** (S.).

§ 113. As stated above, the original function of 'auf' was to denote a motion upward. Whereas the prefixes treated in preceding chapters usually require the addition of the demonstrative particle to give to them the old force of the adverb, 'auf' still appears without such support, because of its very general application, denoting neither a motion toward nor one away from the speaker.

Otfried (9th C.): ***stand ûf!*** (3, 4, 27.)

Tatian (9th C.): thô leita her siê ûz in Bethanian inti ***ûferhabenên*** sînen hentin uuîhita in (244, 2).

mit thiu siê thuruhuuonêtun inan frâgêntê, ***arrihta*** sih ***ûf*** inti quad in (120, 5).

ther heilant habênti sîna hant ***huob*** inan ***ûf*** (92, 7).

. . . uuas nidar gineigit noh zi thuruhslahti ni mohte ***ûf scouuôn*** (103, 1).

Nibelungenlied (12th C.):

> ***ûf ruhte*** si ir gebende: ir varwe wol getân
> diu lûhte ir ûz dem golde (1351, 1).

do er niht wolde erwinden, diu maget ***ûf spranc*** (670, 1).

Reinhard Fuchs (12th C.): ein fuoz begunder ***ûf hân*** unde sere hinken (M.).

Herbort v. Fritslar (12th C.): den schaft ***ûf schutten*** (L.).

Hartmann v. Aue (12th C.):

sô sî wider *ûf gesach*
und weder gehôrte noch ensprach (Iwein 1327).
sîn rüke was im *ûf gezogen,*
hoveroht und ûz gebogen (Iwein 463).

Walther v. d. Vogelweide (12th C.): nû *riht* ich ez [das Haupt] *ûf* nâch vollem werde! (Bartsch 21, 90.)

dô ich dem künege brâht daz mez, wie er *ûf schôz!* (Bartsch 21, 280).

Wolfram v. Eschenbach (13th C.):

si *blicte ûf* und sah ir man (Parz. 800, 29).
ich sach mîns bruoder wâpen tragen
mit *ûf kêrtem* orte (Parz. 91, 11).
ûf liez er doch den wîgant (Parz. 540, 1).
diesen koph mîn ungefüegiu hant
ûf zucte, daz der wîn vergôz
froun Ginovêrn in ir schôz (Parz. 146, 23).

Albrecht v. Halberstadt (13th C.): sîn (des Ebers) borste sich *ûf stalden,* scharpf alse nalden (M.).

Heinrich v. d. Türlein (13th C.): man sach den dicken melm *ûf* mit kreften *stieben* (M.).

Gottfried v. Strassburg (13th C.):

ich weiz es wol, daz in dem sal
ûz maneges mannes munde
lobebrunnen vil begunde
ûf wallen unde enspringen (Trist. 11203).

Minnesinger (13th C.): *ûf gebogen* sach ich dâ wol stênde brâ (M.).

an dem tanz mit dem *ûf hüpfen* (M.).

si *swanc* sich *ûf* reht sam ein vogel (M.).

Luther (16th C.): Der Schmied, so die Kohlen im Feuer *aufbläst* (Jes. 54, 16).

Und Gott *fuhr auf* von Abraham (1 Mos. 17, 22).

Und Aaron *hob* seine Hand *auf* zum Volke (3 Mos. 9, 22).

Joh. Fischart (16th C.): Es ist noch kein Khu *aufgeflogen* (DWb.).

Goethe (18th C.): Er *nam* ein Buch *auf* (19, 88).

Darauf *stiegen* wir verdrieszlich vom Tische *auf* (34, 227).

J. H. Voss (18th C.): Leise mit Kus and Gelispel erweck ich sie, und wenn sie *aufstarrt,* "Schmücke dich," spott ich, "mein Kind!" (DWb.)

Wilbrandt (20th C.): Einige Augenblicke stand sie noch so, dann *richtete* sie sich *auf* (Osterinsel 372).

FIGURATIVE MEANINGS

Lehman (17th C.): Affecten *lodern auf* wie ein Feuer (DWb.).

Klopstock (18th C.): Der heilige Brand bei mir *aufflammte* (DWb.).

Goethe (18th C.): Nun wurden die Überraschungen des Tages wieder *aufgenommen* (besprochen) (S.).

Klinger (18th C.): Lasz mich einen Augenblick in die Luft, eine nie gefühlte Glut *kocht* in meinen Adern *auf* (DWb.).

Wilbrandt (20th C.): Nein, so mein' ich's nicht, *fahr* nicht *auf* (Osterinsel 288).

§ 114. As in preceding chapters the combination 'aus . . . ein' and 'auf . . . ab' were found as frequent formulas, so likewise the pair 'auf . . . nieder' occur frequently. Like the other pairs, it contains two words expressing motion in opposite directions. It is natural that such stereotyped pairs should lose some of their vitality and from expressing two definite directions should come to signify a general motion. Cf. 'hin und her', 'nicht aus noch ein wissen', English 'back and forth'.

Tatian (9th C.): ir gisehet himil offanan inti gotes engilâ *ûf stîgantê* inti *nidarstîgantê* ubar then mannes sun (17, 7).

(Cf. Joh. 1, 51: die Engel Gottes *hinauf* und *herab fahren.*)

Gottfried v. Strassburg (13th C.):

(er) lac ûf sîner strâze
in sô gefüeger mâze,
daz ez noch *ûf* noch *nider wac* (Trist. 6587).

Konrad v. Würzburg (13th C.): vor leide brach er unde *want* die sîne hende *ûf* unde *nider* (M.).

Heinrich d. Teichner (14th C.): *ûf* und *nider vüeren* niht, ie zu hin und dan her wider (M.).

ieder man trîp sin behagen und lâz *ûf* und *nider sagen* (M.).

Klopstock (18th C.):

Wie am Ufer der stolzen Elbe
Der Spreen schwarze Wolke
Vom Gesträuch *auftönt,*
Zum Gesträuch *niedertönt*! (DWb.).

Goethe (18th C.): Das *auf-* und *niedergerückte* Bild (DWb.).

Warum vermagst du nicht die Ahnung zu verscheuchen, die tausendfach in dir sich *auf-* und *niedertreibt?* (S.).

F. Nicolai (18th C.):

Es *strömet* das Blut
Mir in dem Busen *auf* und *nieder* (S.).

Schiller (18th C.):

In der blut'gen Affaire bei Lützen
Ritt er auch unter des Feindes Blitzen
Auf und *nieder* (S.).

Müller-Guttenbrunn (20th C.): Aber als er das Haus der Wielandin verliess und noch immer wartend im Gässel *auf* und *nieder ging* (Glocken 154).

§ 115. For the pair 'auf . . . ab' see § 79.

PART II.

NEW MEANINGS DEVELOPED BY 'AUF'

§ 116. One of the earliest specializations of 'auf' was in compounds referring to the rise of the sun, stars, clouds, etc. The old force of the particle in these compounds is retained because they are very old formations and have become fossilized. During the 18th century the intensive form 'herauf' came to be used in compounds expressing these phenomena, but the old stereotyped forms with 'auf' are still the more common.

Otfried (9th C.): thô *giang* uns *ûf* uunna! thiu êuuinigu sunna (4, 35, 42).

Heinrich v. Veldeke (12th C.): dô der tac *ûf brach* (M.).

Hartmann v. Aue (12th C.):

der morgensterne möhte sîn
niht schoener, swenner *ûf gât* (Iwein 627).

diu wolken begunden
in den selben stunden
von vier enden *ûf gân* (Iwein 643).

Ulrich v. Türheim (13th C.): des morgens dô der tac *ûf schein* (L.).

Marienlegenden (13th C.): des morgens und die sunne *ûf trat* (M.).

Reinfried v. Braunschweig (13th C.): dur grâwiu wolken sach man liehten tac *ûf liuhten* (L.).

Heinrich v. Meissen (14th C.): den morgenstern, der gên tage *ûf dringen* mac (M.).

The earliest of the above examples, the one from Tatian, is used figuratively, showing that the expression for the concrete idea must have existed before that time.

§ 117. One figurative use of compounds with 'auf' is 'to enhance', 'to exalt'. Generally the reference is to ethical values, but it may denote an elevation to a higher social or political position, or a rise in material value.

Tatian (9th C.): uuanta eogilîh ther sih arheuit giôdmôtîgôt inti ther sih giôdmôtîgôt uuirdit *ûf erhaben* (110, 3).

Wolfram v. Eschenbach (13th C.): Schîonatulander an prîse *ûf* muoz *stîgen* (Titurel 128, 1).

Das alte Passional (13th C.): ein keiser der mit gewalt so *ûf schôz* (M.).

Got unser here dich *ûf wac,* daz du pâbest soldest wesen (M.).

Konrad v. Würzburg (13th C.): er kan die schôn *ûf bringen* die gevallen sint da nider (M.).

Luther (16th C.): Wir betriegen und teuschen unternander, *setzen auf* und machen Teurung (DWb.).

Opitz (17th C.):

An überwundner Schar dir desto mehr gebürt
Je mehr die Götter dich hoch haben *aufgeführt* (DWb.).

§ 118. The development of a growing object is generally upward. Hence it is natural that the direction of the act of growing should be designated by the particle (< adverb) 'auf'. The particle with this force, is found prefixed even to verbs which in themselves do not contain the idea of growth, but which have acquired that meaning after being compounded with 'auf'.

Tatian (9th C.): andara fielun in steinahte lant, thâr ni habêta mihhala erda, inti sliumo *giengun ûf* (71, 3). Cf. Luc. 8, 6: und da es *aufging.*

Gottfried v. Strassburg (13th C.):

in den *ûfblüenden* jâren,
dô al sîn wunne solte enstân (Trist. 2072).

Jacob v. Warte (13th C.): man siht das gras *uf dringen* (DWb.).

Das Leben der hl. Elisabeth (13th C.): *uuos ûf* alse ein meien zwîg (M.).

Heinrich v. Meissen (14th C.): ich bin *ûf geschozzen* als ein lustic cêderboum (M.).

Altdeut. Historienbilder (15th C.): das volg ist vaste *ûf geswummen* und ist sêre vaste mechtig gewachsen (L.).

It will be noticed that all of the verbs in the above quotations are intransitive. This lies in the very nature of the action of growing.

Transitive verbs denoting that the object is caused to grow up, or aided in the process, do not occur until the end of the late Middle High German period.

Chroniken d. deut. Städte (14th C.): bôbest Innocencius, der den keiser Friderîchen *ûf gezogen* hette wider keiser Otten (8, 146, 6).

ûf bringen = 'einen gross ziehen, pflegen' (L.).

Luther (16th C.): Das sie (die Knaben) also drei Jahre *auferzogen,* darnach vor dem Könige dienen sollten (Dan. 1, 5).

Wieland (18th C.):

So blühend und so frisch,
Als hätten für Cytherens Bett und Tisch
Die Grazien mit lauter jungen Rosen
Ihn *aufgefüttert* (DWb.).

§ 119. When 'putting up' a building, we think of erecting, elevating it. This idea is added to the verb by the particle 'auf'. Unlike the verbs in the preceding section, most of which are intransitive, all of the verbs in the following quotations are transitive.[87]

Nibelungenlied (12th C.): dô sah man *ûf gespannen* hütten unt gezelt (1304, 2).

Hartmann v. Aue (12th C.): dâ *sluogen* si *ûf* ir gezelt (Iwein 3067).

Gudrun (13th C.): Fruote hiez *ûf swingen* sîner krâme dach (324, 1).

Chroniken der deut. Städte (14th C.): den turm *ûf machen* (L.).

einen graben *ûf werfen* (L.).

Stretlinger Chronik (15th C.): dass si von nüwen *ûf* soltent ein ander hus *buwen* (48, 16).

The particle may refer to the dirt which is thrown up in digging a ditch, or 'ûf' may mean 'open' (cf. next section).

Luther (16th C.): der newlich hat ein Haus helfen *aufhauen* (DWb.).

§ 120. 'Auf' meaning 'open' still shows evidence of its old force in many of the following quotations. Concerning this development Paul writes: "Eine besondere Abzweigung von der Grundbedeutung ist eine Verwendung in der sich auf mit offen berührt als Gegensatz von zu. Ausgegangen muss diese Verwendung von solchen Fällen sein, wo das Öffnen

[87] In the few cases in which this idea is expressed by an intransitive verb the use is figurative. Cf. English: "A new house is going up next to us."

durch Aufheben eines Deckels oder dergleichen geschiet." [38] The earliest quotation I have found bearing out Paul's suggestion is from Wolfram von Eschenbach.

> Parzivâl durch die niftel sîn
> bat *ûf wegen* den sarkes stein (Parz. 804, 27).
>
> sine gôz iedoch niht sêre [ihm Wasser in den Mund]
> unz daz er d'ougen *ûf swanc* (Parz. 576, 19).

Nibelungenlied (12th C.): diu burc was entslozzen, vil wîte *ûf getân* (405, 1).

Hartmann v. Aue (12th C.): *wurfen ûf* daz burgetor (DWb.).

The quotations from Nibelungenlied and Hartmann von Aue suggest that the opening of a medieval castle offered a good starting point for this development. The portcullis was raised or lowered to open or close the castle. To raise the portcullis was equivalent to opening the castle. As the result of the raising was of greater importance than the raising itself, the compound assumed the former meaning. After the idea 'to open' had become associated with 'auf' that particle was employed in compounds which contain no thought of an upward motion.

Walther v. d. Vogelweide (12th C.):

> dîn bluot hât uns begozzen,
> den himel *ûf geslozzen* (Bartsch 21, 440).

Heinrich v. d. Türlein (13th C.): die tür *stiez* er mit der hant *ûf* (M.).

Nithart v. Reuenthal (13th C.):

> diu wât diu was in einem schrîn versperret
> daz wart bî einem staffel *ûf gezerret* (Bartsch 25, 236).

Gudrun (13th C.): dô wart *ûf gehouwen* vil manegez rîchez gadem (1499, 1).

Minnesinger (13th C.): ich *slüeg* in *ûf* als ein veiste kalben (M.).

Hermann v. Fritzlar (14th C.): sîn munt *quam* des nie *ûf* daz her sprêche (Deut. Myst. 1, 163, 3).

Goethe (18th C.): Wenn er gleich das Pergament mit einiger hast *aufrollte* (S.).

The quotations from Nibelungenlied and Walther give evidence that the meaning 'open' had been developed by 'auf' prior to the period for which we have the first records of such a force. At present the relation of 'auf' = 'upward', and 'auf' = 'open' is not felt at all.

§ 121. From what very different situations similar results may be obtained is exemplified by such words as 'aufhalten', 'aufhören', 'auf-

[38] Paul, *Deutsches Wörterbuch*, p. 32. Halle a.S. 1897.

heben', all of which may mean 'to put an end to', 'to stop'. Originally that meaning was but a result of the activity expressed by the verbs. In time the original force of the verb was forgotten and it came to denote the result of the activity, this being the more important.

Nibelungenlied (12th C.):

"ir friunt unde mâge von Burgondenlant,
gehabet ûf des strites, lât hoeren unde sehen,
waz hie deme degene von mînen mannen sî geschehen.
(1989, 3.)

In the next stanza we read:

dô der künec Gunther bat und ouch gebôt,
si *habten ûf* mit swerten in des strites nôt (1990, 2).

The men obeyed Gunther's command and 'held up' their swords. As a result the fighting stopped.

Wolfram v. Eschenbach (13th C.): sîn volc liez er *ûf halden* gar (Parz. 59, 28).

die [sehzec ritter] riefen alle kêrâ kêr:
mit *ûf geworfen* swerten
die kranken strîtes gerten (Parz. 181, 15).

Later 'aufhalten' developed still further to mean 'to stop temporarily', *i. e.*, 'to detain'. The semantic development of 'aufhören' follows.

Hartmann v. Aue (12th C.): dâ mite was dâ *gehoeret* ('aufgehört', M.).

Ulrich v. d. Türlein (13th C.): vater, *hoere,* es ist genuoc (M.).

Ortnit (13th C.): nu heiz den Riuzen *ûf hoeren,* ir habet gnuoc gestriten (ed. Ettm. 68).

In the quotations from Hartmann and Ulrich, 'hören' alone means 'to stop'. In Ortnit, 'aufhören' has this meaning. The difference between 'hören' and 'aufhören', as between 'horchen' and 'aufhorchen', originally was one of intensity only. The prefix 'auf' refers to the action of raising one's head in order to hear better. 'Hören' and the intensive form 'aufhören' acquired the meaning 'to stop', just as in English this is one of the meanings of 'listen', altho it is not yet generally recognized. When several persons are engaged in some activity causing more or less noise, and one of them hears another sound, the cause of which he wishes to ascertain, he says: "Listen!" He may not care whether the others listen or not, but he wishes them to stop making a noise, and he knows they will do this if they try to listen. The cessation of the noise is the important thing, just as a cessation of hostilities was the important thing in the passage from the Nibelungenlied. Hence the verb comes to express what primarily was but a result of the action which it indicated.

Paul explains 'aufheben' meaning 'to put an end to' as having developed from such expressions as "den Tisch aufheben," which meant to end the meal. The expression 'den Tisch aufheben' goes back to a time when the table, that is, the boards constituting a table, were actually lifted up and taken away. In Middle High German the simple verb 'heben' was sometimes used to denote the same thing.[39] From referring to meals, 'aufheben' came to be applied to other activities.

Weisthümer: ein urtel *ûf heben* (M.).

Luther (16th C.): Ich werde ihr Gedächtnis *aufheben* unter den Menschen (5 Mos. 32, 26).

Other compounds to which 'auf' has given perfective force follow:

Walther v. d. Vogelweide (12th C.): den sanc *ûf geben* (L.).

Ulrich v. Zatzikoven (13th C.): daz dervon wart *ûf gesetzet* der turnei der noch siben tage solte weren (M.).

Nicolaus v. Jeroschin (14th C.): er *seite* den vride *ûf* den brudern (M.).

Liedersaal: der kouf wirt *stôzen ûf* ('Handel wird abgeschlossen', M.).

§ 122. 'Auf' prefixed to a verb might give to the compound the meaning 'to originate'. In some of the quotations, the figure seems to be taken from the rising of the sun (cf. § 117), which is identical with the beginning of day. In others, the idea apparently is a further development of the meaning treated in § 119. This is brought about by transferring the emphasis from the period of growth of a plant to the moment of its appearance above the ground, which is identical with beginning an existence.

Heinrich v. Veldeke (12th C.): do daz mære *ûf brach* (M.).

Das alte Passional (13th C.): ein mære *ûf gie* (L.).

dar umme ein kric *ûf trat* (M.).

Monumenta Wittelsbacensia (1300): alle die werren und kriege, die uns biz her *auf gelauffen* sint (L.).

Schaab (14th C.): einen zol *ûf werfen* ('neu einführen', M.).

Urkunde von 1414: unde fursten *ruckten ûf* eine itel newe munze (DWb.).

Fastnachtspiele (15th C.): vil neuer siten sein *auf kumen* (107, 15).

Luther (16th C.): namen Feuerstein und *schlugen* Feuer *auf* (2 Macc. 10, 3).

[39] Cf. fn. [48], p. 131. Cf. also Hartmann v. Aue: swie schiere man die tische *ûf zoch* (Erec 2947).

§ 123. As in English the phrase is used 'to raise our voices', so in German the voice is said 'to go up'. In none of the following quotations is there any distinct thought of a movement upward. The expression 'to raise our voices' may be a result of the blending of two ideas, 'to raise the head' and 'give forth our voices'. The head is raised in order to speak or call more loudly. Or the idea of raising may be based on the figure of elevating an object above other objects and thus giving it prominence.

Minnesinger (13th C.): man hoert daz gefügel *ûf schellen* (M.).

Sanct Alexius Leben: *ûf schrîen* (M.).

Copeybuch der gemainen statt Wienn (15th C.): wann man *aufsag* oder an die grôssen glogken an slag, das ain ieder mit seiner were und harnasch kom (L.).

Stretlinger Chronik (15th C.): . . . und kerte sich wider das volk des herzogen von Burgunn und *rûft uf* also: (8, 5).

Luther (16th C.): Dasz die Weisheit ihr Gebot *aufschreiet* öffentlich in den Strassen (S.).

Klopstock (18th C.):

Scholl da die Hölle nicht dumpf *auf,*
Voll des Entsetzens vor ihm? (DWb.)

J. H. Voss (18th C.):

. . . aber die Jungfrau
That als hörte sie nicht, und gewandt ihr erröthendes Antlitz
Sprach sie ein albernes Wort zu Amalia, *lachte* dann laut *auf.*
(Luise 3, 775).
Als von der obersten Höhe Saturnius schauet die Greuel,
Seufzet er *auf* (DWb.).

§ 124. In the following quotation from Gottfried v. Strassburg 'uf swellen' is but an intensive form of 'swellen'. 'Uf' vaguely denotes an 'expansion' which is already contained in the verb.

Gottfried v. Strassburg (13th C.):

ir begunde ir herze quellen,
ir süezer munt *ûf swellen* (Trist. 11980).

That the verb and not the prefix expresses the idea, is shown by New High German 'anschwellen' and 'aufschwellen', which are synonymous. The primary difference between the two is that in 'aufschwellen' there may originally have been an idea of a rise upon a surface, while in 'anschwellen' the emphasis may have been on the attachment of the swelling to the surface. In the following compounds 'auf' denotes the 'expanding', 'increase in volume', of an object.

Nicolaus v. Strassburg (14th C.): behabe ich daz fûl gelide, sô *gât* ez mir *ûf* an den lip (Deut. Myst. 1, 289, 35).

Konrad v. Megenberg (14th C.): ain *auf geplâsen* plâter (L.).

wenn der mond *aufnimpt* und abnimpt (DWb.).

Stretlinger Chronik (15th C.): Und dabei *gieng* ir buch *uf* und geswal gross als ein flesch (55, 20).

Fastnachtspiele (15th C.): das ir ein peul *auf lief* als ein salzscheib (L.).

The following figurative expressions are from New High German.

Luther (16th C.): Auf dasz sich nicht einer wider den andern um Jemandes willen *auf blase* (1 Cor. 4, 6). Cf. Gothic: ei ains faur ainana ana anþarana *ufblesans* ni sijai.

Lohenstein (17th C.): als der erzurnte Strom die Wellen *aufgeschwellet* (DWb.).

§ 125. The original force of 'auf' is still apparent in compounds like 'aufstehen', 'arise from bed'; 'auftreiben', 'to cause to arise from bed'. By shifting this meaning, the compound may denote merely 'to awaken'. This may have come about as follows: some one says: "Ich *wecke* ihn *auf*" and means to say: "I shall awaken him so that he will arise." He is, however, but partially successful, namely, he wakens the other person, but the latter does not get up. Another explanation of the presence of 'auf' in this compound is to be found in the fact that one frequently starts up, sits up, when suddenly awakened from slumber.

Theo. Gottl. Hippel (18th C.): *aufsingen* ('singend wecken', S.).

Goethe (18th C.): Wenn ich von schweren Träumen *aufdämmere* (14, 63, S.).

Ob es gleich nur ein trauriger Dienst ist, wenn man uns aus einem Lieblingstraume *aufschüttelt* (20, 82).

Herder (18th C.): Den Morgen . . . der todte Welten vom Schlummer *lächelt auf* (S.).

Kosegarten (18th C.): Blätter haben dich oft aus der Ruh' . . . *aufgerauscht* (C.).

§ 126. One force given to the compound by 'auf' is not far removed ideally from that referring to erecting a building. This is the meaning 'to collect in a heap', 'pile up'.

Hermann v. Fritzlar (14th C.): dô nam er ein grôz holz und *rechete* daz fûr mitten *ûf* (Deut. Myst. 1, 61, 24).

Nürnberger Polizeiordnung (15th C.): getreide ***ûfschütten*** ('aufspeichern', L.).

Gryphius (17th C.): ***stoszt*** ir den Holzstosz ***auf*** (DWb.).

Schiller (18th C.): Wir wollen Genua zusammenschmeiszen, dasz man die Gesetze mit dem Besen ***aufkehren*** kann (DWb.).

Müller-Guttenbrunn (20th C.): Er (Danubius) schwang seinen Dreizack und stiess sie (die Eismengen) zurück, ***staute*** sie zu Bergen ***auf*** . . . (Glocken 251).

§ 127. "Ich habe das Holz alle ***aufgearbeitet***" contains a type of another force given a verb by the particle 'auf', namely, 'to put an end to an object'. 'Auf' gives a perfective force to the durative verb 'arbeiten'. This force is more evident in the sentence below.

Athis und Prophilias (13th C.): vil kerzen wart da ***ûf gebrant*** (M.). Originally 'ûf' no doubt referred only to the direction of the flame or smoke. Then by a process already noted, the emphasis was fixed on the time the burning terminated. The result was that the object to which the activity of the verb had applied no longer existed.

The 'auf' of 'aufessen' contains the idea of picking up food and raising it to the mouth to eat it. As noticed before, the prefixes have a tendency to place the emphasis upon the end of an act denoted by a durative verb, that is, to give it perfective force. Thus, from originally indicating but a secondary element in the process of eating, 'auf' has come to denote the completed action. I am not able to explain the semantic development of the compounds in the following sentences. It is probable that analogy plays a part.

Der Ritter v. Staufenberg (14th C.): er liez ***ûf gân*** swaz er gülte hæte (L.).

Luther (16th C.): Da aber das Fleisch noch unter ihren Zähnen war und eh es ***auf war*** (4 Mos. 11, 33).

Gellert (18th C.): Eine Pfeife Taback ***aufrauchen*** (S.).

Ramler (18th C.):

Er thut seinen Rachen auf
Und ***schlingt*** den argen Fresser ***auf*** (S.).

Tieck (19th C.): Ist die ***aufgetragen***, schaft man wol Rath zuner neuen (DWb.).

§ 128. In an earlier chapter I called attention to the fact that several of the particles have developed identical meanings. So the compound 'ausfahren' (§ 11) and 'abfahren' (§ 82) show parallel development with 'auffahren', denoting 'to wear out'. In each case the idea was

originally based on a concrete conception expressed by the prefix. In 'auffahren' the conception is that of the soil being turned up by the wheels of a wagon.[40]

J. H. Voss (18th C.): Denn die Pflasterer haben ihn (den Weg) garstig *aufgewühlt* (DWb.).

Campe (19th C.): Den Weg *aufkarren,* ihn durch vieles Karren auf demselben schlechtmachen, Vertiefungen in denselben bringen.

Den Weg *auffahren,* Löcher hineinfahren.

A closely related conception is that contained in the following compounds. But while the above compounds are based on the old force of the particle meaning 'up', the following seem to have developed from the secondary meaning 'open'.

Weidwerkbuch (16th C.): Die Hund sollen auch, . . . nicht auf die Hasenjagt gebracht werden, denn sonsten sie ire Füsz *auflaufen* (DWb.).

Campe (19th C.): *aufwinden,* wund winden (selten).

Sich die Füsse *aufgehen,* wund gehen.

§ 129. When a particle has been employed in a compound for a long period, it is likely eventually to lose its original force and become paled, or add little to a verb, at most intensifying it.

Pfarrer v. Kalenberg (15th C.): er sprach: pleibt hie, her pfarrer, wo *habt* ir euch *auf?* (811.)

Adam Olearius (17th C.): Da der gesandte zur Audienz sollte *aufgeholet* werden (S.).

Canitz (17th C.): Mein Tisch, mein Haus und Stall, ist kostbar *aufgeschickt* (DWb.).

Klopstock (18th C.): Der ich eine Wolke nur bin, woraus du mich *aufschufst* (DWb.).

Goethe (18th C.): Wo sichs versteckte, wust er's *aufzufinden* (DWb.).

So könnte man auf ein freiwerdendes Quartier *aufpassen* (S.).

So dasz etwas zu Stande kam, was sich *aufzeigen* liesz (26, 43).

Schiller (18th C.):

. . . ein schwedischer Transport,
Den *griffen* die Croaten mir noch *auf* (DWb.).

[40] It is possible that the force of 'auf' in the preceding section may be felt in some of the compounds in this one.

Wilbrandt (20th C.): Adler *horchte auf* aus tiefen Gedanken (Osterinsel 32).

Es empörte ihn; es *reizte* ihn *auf* (Osterinsel 198).

§ 130. In this section are listed a number of compounds which have acquired a specialized meaning in consequence of being employed by various trades, professions, etc., in certain connections.

Monumenta Wittelsbacensia (14th C.): *laufet* chain ûf lauf in unserm land *auf* (L.). Cf. § 126.

Konrad v. Megenberg (14th C.): den slac *ûf heben* [to parry] (L.).

Monumenta Habsburgica (15th C.): die landleut wider den keiser *auf werfen* (L.).

Tschudi (16th C.): der künig hat sie in verdacht, si hettend in (Herzog Hansen) *ufgewisen* [incite] (DWb.).

Luther (16th C.): Wie etliche Geizige blasen thun, die auf benannte Tage Zins *aufheben* (DWb.).

Lasset uns einen Hauptmann *aufwerfen* (4 Mos. 14, 4).

Adam Olearius (17th C.): Ein geiziger Mönch, der hat sein Herz *aufgestellet,* die einfaltigen zu fangen (DWb.).

Ettner (17th C.): Sahe er, dasz der Führer auf ihn zurannte mit *aufgestrichener* Pistole ('pistole au poing', DWb.).

Tieck (19th C.): Sieh, wie schön die Kuchen *aufgegangen* (DWb.).

Aufheben und in die Festung setzen lassen (DWb.).

§ 131. Thus far only those developments of 'auf' have been treated which had their rise in the original meaning of the adverb, denoting a motion in an upward direction. To a smaller extent the secondary meaning of 'auf', namely 'upon', has undergone semantic changes. As the adverb did not assume this force until after the prepositional function had been developed, the period during which changes could take place was not a long one, and consequently the changes are not as great nor as many.

§ 132. One of the earliest specialized meanings of the prefix with its secondary force compounded with a verb, was that referring to 'putting' or 'having' clothes on a person. Since 'auf' refers to a top surface, the compounds in this section refer to covering the head. The particle 'an' is used in connection with other clothes. As in the case of compounds denoting the opposite activity, 'ablegen', 'abziehen', etc., so here we may postulate the ellipsis of the object of the preposition 'auf'.

Exodus (12th C.): die *sazzeten ûf* ir houbet die helme (M.).

Nibelungenlied (12th C.): ir helme und ouch ir prünne si *bunden ûf* diu marc (891, 1).

Wolfram v. Eschenbach (13th C.):

. . . ieslîcher truoc
helm *ûf* houbt *gebunden* (Parz. 210, 21).

The next stage is a sentence of the type:

Er hêt in kurzen stunden
den helm *ûf gebunden* (Iwein 4974).

After the type had been established, it was possible to extend this use of the particle by means of analogy.

Nibelungenlied (12th C.):

dô sah der junge Giselher sînen sweher gên
mit *ûf gebundem* helme (2171, 2).

Walther v. d. Vogelweide (12th C.): mit den bluomen als irs *ûffe traget* (M.).

Das alte Passional (13th C.): er hatte ein grûne krenzelîn von eime olboume *ûf gesat* (M.).

Chroniken d. deut. Städte (14th C.): die helme *ûf stürzen* (8, 80, 15).

Luther (16th C.): und sol den linnenen Hut *aufhaben* (3 Mos. 16, 4).

Jean Paul Richter (18th C.): Bürgerkrone, die er *auf bekäme* (DWb.).

Alexis (19th C.): Eine Kopfbekleidung *aufstülpen* (S.).

§ 133. In Middle High German 'uf geben' meant 'to give up', 'to surrender'. The two following sentences seem to indicate that the meaning of the particle is developed from the force 'upon'.

Margrave v. Hohenburc (13th C.): er *gap* sich *ûf* die triuwe mîn (Bartsch 19, 54).

Nibelungenlied (12th C.):

ir helde, ir sult mir s'*ûf geben* [die Waffen]
ich wils' behalten lân (1745, 3).

Similar metaphors as these apply to the following sentences, but in most cases they have faded beyond recognition.

Heinrich v. d. Türlein (13th C.): Gawain daz in schimpf *ûf nam* (L.).

Monumenta Zollerana (13th C.): er sol daz guot *ûf ziehen* und aigen in allen dem rehten als man andriu guot ûf ziuhet und an sich aiget (L.).

Klinger (18th C.): ein Frauenzimmer ***aufgeben*** ('sitzen lassen', DWb.).

§ 134. A large number of verbs compounded with 'auf' have a person in the dative as the goal of the motion of the verb. All of them are used figuratively. The verbs are transitive and generally signify that some quality, a guilt, an honor, or other abstract conception, has been placed upon the person, usually to the person's detriment. But, it may also be for his benefit. The dative may be interpreted as one of reference.

Albrecht v. Johansdorf (12th C.): wer hât iuch, vil lieber man, ***betwungen ûf*** die nôt? (Bartsch 11, 50.)

Das alte Passional (13th C.): Got wil in ***ûf werfen*** ein joch (M.).
welch wort im was ***ûf gezogen*** und wie sie habe betrogen Theodorus (M.).

Konrad v. Würzburg (13th C.): fröuten sich der mære daz in der orden wære ***ûf gesetzet*** und geblieben (M.).

Nicolaus v. Jeroschin (14th C.): welch ein joch die Rîgêre ***tribin*** dort den brûdrin ***ûf*** (M.).

Fastnachtspiele (15th C.): im sol niemant kein Sorge ***aufthun*** (DWb.).

Luther (16th C.): ich wil euch ein Räthzel ***aufgeben*** (Richt. 14, 12).
Wenn Jemand ein Weib nimmt und wird ihr gram, und ***legt*** ihr was schändliches ***auf*** (5 Mos. 22, 14).

Felsenburg (18th C.): Ja, ich war einsmals so verwegen eben dieses dem Kaiser selbst, da er bei guter Laune war, ***auf*** zu ***binden*** (DWb.).

Goethe (18th C.): Bewirtet er uns mit fetter Schafmilch, die er als höchst gesunde Nahrung pries und ***aufnöthigte*** (31, 223).
Viel zudringlicher noch ***packt*** sich Armor uns ***auf*** (1, 307, S.).
Dem Gerichtshalter und mir ist das ganze Geschäft ***aufgewälzt*** (20, 245).

Klinger (18th C.): einem seine Freundschaft ***aufdrängen*** (DWb.).
So sieht es leider mit gar vielen Opfern aus, die uns als grosze erhabene Thaten ***aufgedrungen*** werden (DWb.).

§ 135. 'Auf' may give the force 'to postpone' to a compound in which it occurs.

Heinrich v. Veldeke (12th C.): dô wart diu rede ***ûf geschoben*** (M.).

Wernher (14th C.): got *schiubet ûf* lange sîne gnâde swenner wil (M.).

The figure is that of pushing a thing forward from one position to another, farther removed. Cf. "Schiebe es nicht von einen Tag auf den anderen." Luther (quoted by Paul—Wb.).

Konrad v. Würzburg (13th C.): daz urliuge *ûf geslagen* (M.).

§ 136. The following quotations contain compounds with the prefix 'auf' which have acquired specialized meanings. Altho the goal is omitted in all of them, it can be supplied from the context. Many of the expressions are figurative, but the concrete force 'upon' can be recognized.

Hartmann v. Aue (12th C.): dô begund er sich *ûf machen* (auf d. Weg, M.).

er *saz ûf* und reit (Iwein 967).
die vinger wurden *ûf geleit*
alsus gap si den eit (Iwein 7923).

Herbort v. Fritslar (12th C.): daz si sîne vart heten *ûf geleit* (M.).

Wolfram v. Eschenbach (13th C.): dô was ouch *ûf geleit* daz prôt (Parz. 165, 15).

Alpharts Tod (13th C.): fiur *ûf slahen* ('auf dem stein') (M.).

Hermann v. Fritzlar (14th C.): daz ich dir alle dinc gegeben habe, âne mine vrowenlichen êre, di wolde ich gern behalden haben; nu *trage* ich dir si *ûf* (Deut. Myst. 1, 244, 27).

The figure is that of serving something on a plate or placing on a table.

Heinrich v. Neuenstadt (14th C.): irn dörft nicht meinen, das ich iuch wolle lenger *ûfzien* [auf die Folter] (L.).

Der Veter Buch (14th C.): gegen einander *ûf treten* (auf den Plan) (L.).

Pfarrer v. Kalenberg (15th C.):

er sprach, ob er wolt wider han
sein pfarr im wechsel oder kauf,
so solt er im bar *geben auf*
der alten müntz wol dreissig pfundt (488).

Luther (16th C.): Mit dem vorigen Pfarrer abzuziehen und mit diesem genannten *aufzuziehen* (auf ein Grundstück) (S.).

Sebastian Frank (16th C.): In kriegn, die er ausz Notwär *aufnemen* musz (DWb.).

A figure taken from picking up the gauntlet.

Grimmelshausen (17th C.): Mit fertigem Gewehr und *aufgepassten* Lunten (DWb.).

The compounds referring to playing on an instrument come under a subdivision of this section.

Nithart v. Reuenthal (13th C.): *strîchet ûf* einen rechten hovetanz, die rechten hovestriche (M.).

Das alte Passional (13th C.): die spilliute *ûf slûgen* (M.).

Fastnachtspiele (15th C.): *schlag* ein reien *auf!* (552, 6.)

Joh. Fischart (16th C.): Trommeter *blas auf!* (DWb.).

As 'abspielen', 'absingen' frequently has the connotation to 'sing thru to the end', so 'auf' in the preceding passage may indicate that stress is laid on the beginning of the activity. (Cf. §§ 123, 137.)

Another subdivision of this section contains verbs having become specialized to denote 'to make an appearance', usually with more or less formality. The figure is taken from the stage (cf. der Auftritt < auf die Bühne treten), or entering upon some other place for purposes of display. Then the figures are expanded to other situations.

Seifrid (14th C.): si begunden *ûf rîten* mit den hunden (L.).

Luther (16th C.): Und alle seine Söhne und Töchter *traten auf*, das sie in trösteten (1 Mos. 37, 35).

Kirchhof (16th C.): Die Wache *aufführen* (DWb.).

Gryphius (17th C.): Er *zeucht* zwar nicht mit purpur *auf!* (DWb.)

Goethe (18th C.): Wenn sie das Lied singen und *aufführen* wollen (S.).

Klinger (18th C.): Dort kommen sie *aufgefahren* (DWb.).

Die Leute zum Hofstaat *aufstellen* (DWb.).

Schiller (18th C.): Unser gnädigster Landesherr liesz alle Regimenter auf dem Paradeplatz *aufmarschieren* (DWb.).

Compounds denoting that something has been put on paper, into a book, etc., also belong in this section. No records of this use were found earlier than the 16th century.

Paracelsus (16th C.): Doch aber (diese Bilder u. Figuren) nicht ohne grosze Ursach da sind, und von den alten Magis angezeichnet und *aufgerissen* worden (DWb.).

Goethe (18th C.): Sobald er die Kreide [zum Rechnen] nam und was er *aufmachte*, war ihr recht (S.).

Jean Paul Richter (18th C.): Vortreffliche Werke *aufgesetzt* haben (DWb.).

Eichendorff (19th C.):

Der eine macht Geschichten
Der andre *schreibt* sie *auf* (DWb.).

§ 137. 'Auf' was formerly prefixed to a number of verbs which are now compounded with some other particle. They follow in alphabetical order of the prefix which has supplanted 'auf'.

AB.

Matthesius (16th C.): Darum wollen wir nicht *auflassen,* und sein Thorheit vollend aller Welt fürstellen (S.).

AN.

Gottfried v. Strassburg (13th C.):

er *huob ûf* und seite in,
daz ime gesaget wære
vür ein wârez mære (Trist. 18238).

The newer 'anheben' is formed in analogy to many other verbs containing that prefix and meaning 'to begin'. The same explanation applies to 'aufblasen' of the following quotation (cf. § 163).

Wolfdietrich (13th C.): daz her horn *ûf blâsen* (V, 208, L.).

Fastnachtspiele (15th C.): den spot musz ich do *aufnemen* (107, 25).

The older writer 'took scorn upon himself', now we 'take scorn unto ourselves', in German.

Keisersberg (15th C.): das du darumb nit strackes mit inen *uf bindest* und glichs in harnisch seiest (DWb.).

Murner (16th C.): Das *aufgenommene* Geld (S.).

'Geld aufnehmen' has acquired a specialized meaning, 'to take up a loan'.

Campe (19th C.): Ein Wort *aufführen,* es nach der Abezereihe am gehörigen Orte anführen, desselben Erwähnung thun.

AUS.

Luther (16th C.): Denn seid keine Pfaffen noch Münche, und halt des Babsts Gesetz nicht, gleubt im nicht, das es Sünde gewesen sei, was er für Sünde *aufgibt* (DWb.).

Grimm (19th C.): Ich habe diesen Menschen noch nicht *auffragen* können (DWb.).

Tieck (19th C.): Truppen *aufheben* ('gewöhnlich ausheben', S.).

EIN.

Berthold v. Regensburg (13th C.): Got hat die ê *uf gesetzet* (M.).

Iffland (18th C.): Wollen Sie mich bei der Frau Hofräthin gefälligst *aufführen* (S.). The parlance of the stage may have influenced the playwright, Iffland.

UM.

Stadtrecht v. München: die schidunge *ûf stôzen* ('die schiedsrichterliche Entscheidung anfechten, umstossen', M.).

UNTER.

Grimmelshausen (17th C.): Märlein, damit man die Kinder *aufhält* (DWb.).

ZU.

Mai u. Beaflor (13th C.): Bêaflôr diu guote *nam ûf* an süezem muote (M.).

§ 138. Finally, there are some compounds which have become so highly specialized that they could not be fitted into any of the preceding categories. Most of them are developments of the older function of 'auf', 'upward'.

Chroniken der deut. Städte (14th C.): sich vür einen kung *ûf werfen* (4, 116, 15).

Des Teufels Netz (15th C.): den lîp *ûf machen* ('aufputzen', L.).

Luther (16th C.): Der Mensch soll *aufnehmen,* das alles von Gott zugeschickt werde (DWb.).

Matthesius (16th C.): Alle, die sich wider diese Schul und Kirch zu Wittenberg *auflegen* (DWb.).

Goethe (18th C.): Herder soll doch *aufstellen* [acht geben], er sieht vielleicht in einem Katalogus dies interessante Werk (29, 292).

Auerbach (19th C.): Wir sind Manns genug, für den Schaden *aufzukommen* (S.).

Specialized meanings derived from the secondary force of the adverb:

Luther (16th C.): Man *trug* ihm besonders *auf* und jenen auch besonders (1 Mos. 43, 32).

Weckherlin (17th C.):

Wan schon mit List, Gewalt, Macht, Schmach
Vil hunterttausend mir *aufpassen* (DWb.).

Günther (18th C.): Blos weil mich die Natur zum Mitleid *aufgelegt* (DWb.).

Lessing (18th C.): Ich darf das Buch nur *auffallen* lassen, wo es auffallen will (DWb.).

PART III.

'HERAUF' AND 'HINAUF' WITH THEIR ORIGINAL FORCES

§ 139. 'Herauf' and 'hinauf' denoted a direction opposite to that indicated by 'herab' and 'hinab'.

Parzival, 372, 22 following, contains these words:

der fürste Lippant kom geriten
an dem berge enmitten.
Obylôt und Clauditten
saher vor im *ûf hin gên*.

Every word in the last line still had vital force for Wolfram. The prince saw the two ladies before him (vor im); they were ascending (ûf), and going away from him (hin). The ideas contained in 'ûf+hin' are now expressed by the compound 'hinauf', the elements of which have lost their individuality thru the process of composition, that is, they have been blended into one idea.[41]

In the next passage the secondary force of 'ûf' is shown.

Wolfram v. Eschenbach (13th C.):

si hete mit ir hende
underm kinne daz gebende
hin ûfez houbet geleit (Parz. 515, 1+).

'Uf' is a preposition meaning 'upon'. 'Hin' denotes a motion 'away from'; obviously this does not refer to the speaker, but the speaker thinks of the original position from which the bands are removed, *i. e.*, the chin. While these examples show that Wolfram still felt the force of the individual words 'hin' and 'auf', he also employs 'hinuf' as a compound prefix.

§ 140. Altho neither the works of Otfried von Weissenburg nor the Tatian translation contain examples of either 'herauf' or 'hinauf' compounded with the verb, Graff records several such combinations from other Old High German writers.

Notker (10th C.): *fliug hara uf* in berg (G.).

Zeitsch. f. deut. Altertum: den berg Tabar *her ûf clamp* (17, 35).

Meister Eckhart (14th C.): *her ûf sprichet* Dâvît . . . (Deut. Myst. 2, 27, 2).

Vom Herkommen der Schwyzer (15th C.): und *suhent* den *heruf*, als das Plinius . . . , schribt in siner cronick (183, 1).

Notker (10th C.): *denschint hinâ ûf* (G.).

unz man *follechumet hina uf* ze demo gotes hus (G.).

unz er *hina ufchomet* (G.).

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[41] Additional examples are:

so'r *ûf hin komet* an den grabn,
ich wæn dâ müezt ir stille habn (Parz. 225, 27).
Gâwân die strâze al *ûf hin reit* (Parz. 508, 14).
Hêrre, swenne ir *ûf hin kumt* [hinauf zur Burg],
ein dinc iu zem orse frumt (Parz. 561, 3).

Boethius (10th-11th C.): ***hina uf fliege*** daz liehterâ fuir (G.).
hin uf kestîgen (G.).

Nupties Marcurii et philologiae (10th-11th C.): *far* ***hina uf*** (G.).

Wolfram v. Eschenbach (13th C.):

undr eine baniere wîz
ist er ***hin ûf gevangen*** (Parz. 673, 13).

er ***steic hin ûf*** an daz lant (Parz. 602, 28).

Lirivoyn rief al diu schar,
die under der durch strîten riten:
die hânt den prîs ***hin ûf erstriten*** (Parz, 673, 20).

Stretlinger Chronik (15th C.): do er nu ***hinuf*** an den galgen ***gefüert*** wart von dem henker . . . (119, 29).

. . . do ***gieng*** er mit grossem zorn us der kilchen ***hinuf*** zu sinem hus (102, 9).

§ 141. The above list of quotations contains one example of 'herauf' and six of 'hinauf' prefixed to a verb by Old High German writers. During the Middle High German period, three compounds with the former and five with the latter prefix were added, showing an early preference for 'hin', as an added particle to strengthen 'auf'.

STATISTICS ON THE SPREAD OF 'HINAUF' AND 'HERAUF'

	'HERAUF'	'HINAUF'	TOTAL
Old High German period	1	6	7
Middle High German period	3	5	8
Luther	9	10	19
Rest of 16th Century	—	3	3
17th Century	2	7	9
Goethe	10	16	26
Rest of 18th Century	17	38	55
Campe	127 (18)	98 (16)	225
19th Century	9	6	15
	178	189	367

PART IV.

NEW MEANINGS DEVELOPED BY 'HERAUF' AND 'HINAUF'

§ 142. 'Auf' with a verb denoting the rising of the sun, stars, etc., was shown to have become a stereotyped expression still commonly used in its old sense. During the 18th century the simple particle 'auf' was occasionally thought to be too weak to denote these natural phenomena, and 'her' was added as an intensive element.

Gessner (18th C.): Die frühe Morgensonne flimmerte schon hinter dem Berge herauf (DWb.).

Klopstock (18th C.): Wenn der Abendstern am einsamen Himmel *heraufgeht* (C.).

Als die Sonne nunmehr hinsank, und das Dunkel *heraufzog* (C.).

Goethe (18th C.): *Bringt* der Tag eine Sonn *herauf* (S.).

Wenn . . . von der hinabgewichenen Sonne ein zitternder Schein am Horizont *heraufdämmerte* (18, 33).

Hölty (18th C.):

Schnell *rollten* Wetterwolken,
Von Blitz und Donner schwer,
Herauf (DWb.).

Klinger (18th C.): Die Sonne *treibt* so eben den Horizont *herauf* (DWb.).

Jean Paul Richter (18th C.): Er kriegte noch in sich, als der hinter ihrem Rücken *heraufgehobene* Mond ihre beiden Schattenkniestücke vor ihnen voraustrieb (DWb.).

Kinkel (19th C.): Die Abendsonne *blitz herauf* (S.).

Wilbrandt (20th C.): . . . vom Südosten her *stieg* aber, wie es schien, . . . Föhngewölk *herauf* (Osterinsel 313).

§ 143. The breath which enables people to utter sounds, comes from the lungs, which are located lower down than the mouth, where the sounds issue forth; hence, the particle 'auf' might be expected in connection with a verb to express the idea of a sound given forth. 'Her' is added to intensify the idea. The preference of 'her' to 'hin' is explained by the fact that one is inclined to locate himself in one's head, that is, at a point higher than that in which the breath (voice) originates. Hence the approach, figuratively speaking, is toward the speaker.

Gessner (18th C.): Was ist Das . . . , das aus meinem Busen *herauf seufzt?* (S.).

Klinger (18th C.): Dunkle, quälende Weissagung *drängt* sich aus meinem Herzen *herauf* (DWb.).

Alxinger (18th C.):

Nachdem er erst nicht ohne Müh
Die Stimme (denn der Zorn erstickte sie)
Herauf geschöpft, . . . (DWb.).

Gotter (18th C.):

. . . *athmet* matt
Ein Lebewohl *herauf* (DWb.).

Ense (19th C.): Die aus der innersten Seele ***herauftönende*** Stimme (S.).

Freytag (19th C.): Es war Stolz, es war Neid, der aus einem bedrängten Leben ***heraufquoll*** gegen Glücklichere (DWb.).

The following is the only quotation with this meaning compounded with 'hinauf'.

Gessner (18th C.): Verdrücke den Seufzer nicht, der deinen Busen ***hinauf dringt*** (A.).

§ 144. In § 119 it was shown that 'auf' was frequently prefixed to verbs denoting 'to grow up', or 'to bring up'. The double prefix 'herauf' is also added to verbs with this signification. The expanded form of the prefix does not occur before the end of the 18th century, 'auf' having become the stereotyped form.

Goethe (18th C.): Hat ich nicht selbst sie genährt, und sanft sie ***herauf*** mir ***erzogen*** (1, 324).

(Krebse), . . . die er denn auch nachher durch besondere spagirische Nahrung zu merkwürdiger Grösze ***heraufzufüttern*** verstehe (31, 227).

Und so *wuchs* ich ***herauf***, ein Ebenbild des Vaters (9, 29).

Uhland (19th C.):

Doch *sproszt* auch jedem aus dem düstern Gram
Ein süszes ahnungsvolles Glück ***herauf*** (DWb.).

§ 145. The expanded prefix could have an almost identical force with that of the simple one, as was shown in the section just treated. The same condition exists for verbs given the force 'to arise', 'come forth', 'originate', etc., by the prefix 'auf'.

Klopstock (18th C.):

Dein unermesslicher Kreis ***heraufgerufen*** zum Dasein
Bildete sich zu seiner Gestalt (C.).

Goethe (18th C.): Die schöne hippokratische Verfahrungsart, wodurch sich, ohne Theorie, aus einer eignen Erfahrung, die Gestalten des Wissens ***heraufgaben*** (26, 9).

Schubart (18th C.):

Da *sprang* die Natur
Herauf aus des Undings Nacht (S.).

Gutzkow (19th C.): Die vorübergegangene Gelegenheit (be)-*schwört* keine Macht wieder ***herauf*** (S.).

§ 146. The secondary meaning of 'auf', indicating the upper surface of a thing, may also be denoted by the expanded forms.

Campe (19th C.): Es *geht* nicht alles *herauf* (auf den Tisch)
hinaufbauen = auf jenen Ort hinbauen.
hinaufstürzen = auf Etwas hin stürzen.

Rosegger (19th C.): Vom Papier habe ich's gelesen und die Bayern haben es *hinauf gedruckt* und es ist alles falsch! (Peter Mayr 244.)
In der Ortschaft nahmen sie einen Bauernwagen, *warfen* den Gefesselten *hinauf* (Peter Mayr 360).

§ 147. In the following sentence from Goethe, the common usage today calls for the simple 'auf', or the phrase "in die Höhe." If, however, we were to use a double prefix, we should probably take an objective attitude and employ 'herauf'. Goethe, however, identified himself with the subject.

Goethe (18th C.):

Dich nur sah ich, nur dich am Boden knieend, verdrieszlich;
Mit der einen Hand *hielst* das Gewand du *hinauf* (1, 310).

§ 148. There remain a few quotations in which a compound with 'hinauf' is used in a specialized sense.

Schiller (18th C.):

Eures Haders Ursprung *steigt hinauf*
In unverständ'ger Kindheit frühe Zeit (S.).

Adelung (18th C.): Eine Untersuchung bis zur Sündfluth *hinauf treiben.*

Gutzkow (19th C.): Es *läuft* sich wohl hoch *hinauf* (S.).

SUMMARY

§ 149. The following points have been developed in this chapter.

1). Like the particles treated in preceding chapters, 'auf' was originally an adverb of direction. It indicated that the motion of the verb with which it was compounded was upward, without further specifying the goal.

2). The adverb 'auf' assumed the function of a preposition meaning upon the top surface.

3). Under the influence of the preposition, the adverb developed a secondary meaning, 'upon'.

4). Specialization, starting from the original force of the adverb, began during Old High German times. Changes of meaning took place during the early Middle High German period.

5). Specialization and semantic changes based on the secondary meaning of the adverb began during the early Middle High German period.

6). As a result of the development noted above the old force of the adverb was lost.

7). As in the case of the prefixes already treated, 'her' and 'hin' were added to the weakened 'auf' to restore to it its old function denoting motion upward, with the additional force of indicating the direction toward or away from the speaker.

8). The double prefixes 'herauf' and 'hinauf' have not undergone any semantic changes, altho they are showing a tendency toward specialization in several instances, and in a few cases there is evident confusion regarding the use of 'herauf' and 'hinauf' as indicating the direction in respect to the speaker.

9). There are more than twice as many verbs compounded with 'hinauf' as with 'herauf'.

CHAPTER V.

AN, HERAN, HINAN

Part I.

'An' with its Original Force

§ 150. It is probable that the original function of 'an' was that of a preposition. In fact, all of the meanings developed by the particle may be traced to a prepositional force. It indicates proximity to or contact with an object, the relation being to the exterior generally. It might also indicate a motion to or toward such a position, according to whether the object of the preposition is in the dative or accusative. In their development the compounds with 'an' in nearly all cases still retain traces of these meanings of the preposition.

§ 151. A number of verbs formerly compounded with 'an' contained the same force which can now be expressed only by the double compound 'heran' as is shown by the following quotations. It is interesting to note that none of the following compounds would have the prefix 'hinan'.

Otfried (9th C.): ni dua thir thia arabeit, uuanta âband unsih *anageit* (5, 10, 5).

Dietrichs Flucht (13th C.): diu naht begunde *slîchen an* (M.).

Weckherlin (17th C.): Der Sommer *dringet an,* eh kaum der Lenz dahin (DWb.).

Grimmelshausen (17th C.): damit sie andere desto besser *anlassen* (an d. Spiel), verspielen sie oft freiwillig etwas weniges (DWb.).

Jean Paul Richter (18th C.): lauerte eben auf den *anhüpfenden* Finken (DWb.).

Bürger (18th C.):

> Allmählich hub er an
> Sich näher *anzudrehen* (DWb.).

J. H. Voss (18th C.): Kam, laut *anbrausend* der West (DWb.).

Freiligrath (19th C.):

> *Ankeuchen* schon die Hunde
> Herrgott zum Halali (DWb.).

§ 152. A motion toward an object is indicated by the compounds in the following quotations, often in a figurative sense. An arrival at is frequently implied.

Otfried (9th C.): ouh *blias* er sie *ana* then selbon heiligon Geist (5, 11, 9).

er tod sih *anauuentit,* in themo thritten dage erstentit (1, 15, 34).

. . . nâmun sie tho steina
thaz sliumo sies gehulfîn ioh inan *anawurfîn* (3, 18, 70).

Tatian (9th C.): ther thie ûzan sunta sî iuuar zi êristen *sente* sia stein *ana* (120, 5).

in ist giscinfit inti uuerdit bifillit inti *anagispiuuan* inti arhangan inti thritten tage arstentit (112, 1).

Notker (10th C.): *uuahet* sie *ana* sin geist (DWb.).

Stretlinger Chronik (15th C.): . . . do viel si vor dem altar nider und *kam* si ein grosser schmerz *an* (89, 21).

Luther (16th C.): und *kamen an* zu Tyro (Apostelgesch. 21, 3).

Fischart (16th C.): *an* dem *seind,* dasz sie ersaufen wollen (DWb).

The figurative meanings expressed in the following quotations are self-explanatory.[42]

Otfried (9th C.): forahtun sie in thô gâhun, sô si inan (d. Hirten den Engel) *anasahun* (1, 12, 5).

beginnet *anascouuôn* thiô frônisgon bluomen (2, 22, 13).

sô thisu uuort (der Magier) thô gahun then kuning *anaquâmun* (1, 17, 29).

Nibelungenlied (12th C.): die übermüeten degne *sâhen* alle einander *an* (1730, 4, DWb.).

Hartmann v. Aue (12th C.):

dô er sich ûf gerihte
und sich selben *an blihte* (Iwein 3506).

In the following the voice is thought of as being sent toward an object in the hope of reaching it.[43]

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[42] Middle High German examples containing the prepositions with this force are:

Nibelungenlied: der künec *an* Hagenen blihte (1919, 1).
Wolfram v. Eschenbach: *an* Herzeloyden er do sach (Parz. 96, 23).

[43] The preposition could be used with the same force.

Wolfram v. Eschenbach:

Flegetânis, der *an* ein kalp
bette als ob ez wær sîn got (Parz. 454, 2).
ine mac niht wol benennen gar
an den ruoft der *heiden* sunderschar (Wilh. 372, 2).

Gottfried v. Strassburg: dâ *kam* si dô ze frumen *an* ir meister (Trist. 8003).

Kaiserchronik (11th C.): den die Kristen ***ane beten*** (M.).

Hartmann v. Aue (12th C.):

der wec wart vinster und tief
daz sî got ***ane rief***
daz er ir nôt bedæhte (Iwein 5792).

Wirnt v. Gravenberg (13th C.): dô kom ein hund und ***bal*** si ***an*** (M.).

Stretlinger Chronik (15th C.): Do hûb uf der vil genant Theodricus von Stretlingen sine fust und hand und tröwt dem selben löwen mannlich und ***schrei*** in ***an*** (6, 21).

§ 153. The other old force, *i. e.*, indicating contact with an object, is shown in quotations of the present section.

Tatian (9th C.): ***gôz*** thara ***ana*** oli inti uuin [an die Wunden] (128, 9).

Hartmann v. Aue (12th C.):

dâ hiez sî si ***strîchen an***:
so entwiche diu suht dan (Iwein 3445).

Biterolf (13th C.): der ditze mære ***an schreip*** (M.).

Ulrich v. Lichtenstein (13th C.): seht wie diu frowe sich ***strîchet an*** (M.).

Predigten d. 13. Jh.: die slege die man dich hie ***anleget*** (M.).

Ayrer (16th C.):

Ein köstlich Wein
damit solt ihr Ochsen und Trachen ***anspritzen*** (DWb.).

Grimmelshausen (17th C.): Die armen Bauern erfahren es besser als man es alhier ***ansetzen*** kan (DWb.).

Gryphius (17th C.): Dem ***schmiert*** er Aufruhr ***an***, der hat das Volk verhetzt (DWb.).

Goethe (18th C.): Ein Marktschreier, der sich bei mir ***anzustreichen*** gewust [with the connotation 'gut'] (11, 54).

Part II.

New Meanings Developed by 'An'

§ 154. In § 152 the compound 'ansehen' is used in its original sense without any connotation. An object at which we look may awaken various feelings within us. The emotional condition thus aroused is of more importance than the mere act of looking toward or at an object, and consequently determines the conceptual content of the compound.

Hartmann v. Aue (12th C.): nu *schînet* êrst *an* dir dîn triuwe (M.). The preposition shows the probable origin of the particle.

Old High German: daz *skinet* dir *ana* (G.).

Hartmann v. Aue (12th C.):

der selbe *sach* im daz wol *an*
daz er niht rehtes sinnes was (Iwein 3288).

daz er *an* den werken *sach*
daz sin wille und sîn muot
was reine und guot (Iwein 5602).

daz mir daz solde geschehn
daz ich müese *an sehn*
schaden und schande
in mîner vrouwen lande! (Iwein 3986.)

Wolfram v. Eschenbach (13th C.): die *sah* ich für die sunnen *ana* (Parz. 91, 6).

Keisersberg (15th C.): als mich die sache *ansicht,* so bist du ein profet (DWb.).

Luther (16th C.): Du *siehest* die Schatten der Berge für Leute *an* (Richt. 9, 36).

Fischart (16th C.): Ich *seh* euch an der Nasen wol *an* (DWb.).

Fr. Müller (18th C.): In diesen zwe Tagen wurde der Aufwand von 700 Pfund nicht *angesehen* (S.).

Goethe (18th C.): Mit alledem war das Paar nicht *unangesehen* auf der Oberwelt (S.).

§ 155. As was shown in the preceding chapters, the emphasis of a durative action might be placed on any stage of the progress indicated by the verb, the most important stages being the starting point and goal. In the following list of verbs the goal is the more important factor, the force of the compound being to indicate an arrival at an object.

Wulfilas (Gothic): aggilus fraujins *anaqam* ins (Luc. 2, 9).

Pfaffe Konrad (12th C.): elliu diu zîrde di mich von erbe *an chomen* ist (M.).

Heinrich v. Veldeke (12th C.): der scône somer *gât* ons *an* (Bartsch 7, 158).

Sebastian Frank (16th C.): als das den Keiser *anlanget,* ward er in einen Stall verschaft (DWb.).

Musäus (18th C.): Er *gelangte* in seinem Waldschloss *an* (S.). The connotation in the next two sentences has given the meaning to the phrase 'schön oder schlecht ankommen'.

Weisse (18th C.): Ich habe ihm schon gesagt, dass er bey mir unrecht ***ankommt*** (A.).

Goethe (18th C.): . . . konnte ich nicht umhin den Vorfall einem Manne zu erzählen, aber wie ***kam*** ich ***an!*** er sagte das sei sehr übel gewesen (16, 50).

The meaning 'to announce' acquired by certain compounds with 'an' is probably the result of a contamination of two ideas,—"er bliess (ins Horn) als sie ankamen." Cf. "den Zug abrufen" = 'rufen dass der Zug abfahre'.

Lohenstein (17th C.): Sie ***bliessen*** mit Krummhörnern die annahenden Sieger freudig ***an*** (DWb.).

O. Müller (19th C.): Dem Brautpaar die Ehe ***anschiessen*** (S.).

§ 156. A still further development is that indicating not only proximity to or contact with, but 'attachment' to an object.

Tatian (9th C.): daz ***ana*** sî ***hangan*** quirnstein in sînan hals (94, 4).

Nibelungenlied (12th C.): du hâst mich ze dienste mit rede dich ***an gezogen*** (842, 2).

Deut. Gedichte d. 12ten u. 13ten Jh.: daz du dich lieze ***an slahen*** [an d. Kreuz] (M.).

Brant (15th C.): Knöpflin ***setzen an*** (DWb.).

Fischart (16th C.): Wie man die Ferklein ***ansteckt*** [an d. Spiess] (DWb.).

Menantes (18th C.): ***Häkelt*** sich ***an*** durch ein verliebtes Band (DWb.).

J. H. Voss (18th C.): Dasz nicht ***anbrennte*** die Speise (DWb.).

Schiller (18th C.):

> Wie der Baum sich in die Erde schlingt
> Mit seiner Wurzel Kraft und fest sich kettet,
> So ***rankt*** das Edle sich, das Treffliche
> Mit seinen Thaten an das Leben ***an*** (S.).

The object to which something is attached may be in the dative. This is a sort of dative of possession.

Tatian (9th C.): thiê (diebel) giuuesso biroubôtun inan inti vvuntûn ***anagitânên*** (128, 7).

Meister Eckhard (14th C.): daz lieht daz ir ***angeschaffen*** ist (Deut. Myst. 2, 410, 36).

Jonas (16th C.): So doch auch die Schrift klar sagt, das uns solchs (d. Erbsünde) alles nicht ***angeflohen,*** sondern angeboren sei (DWb.).

Luther (16th C.): Schlug seine Feinde von hinten und *henget* inen ein ewige Schande *an* (Ps. 78, 66).

Sebastian Frank (16th C.): Daher Phebus erzürnet, *bildet* dem Midas Eselsohren *an* (DWb.).

Lohenstein (17th C.): So sucht man deinem Ruhm ein Brandmal *anzubrennen* (DWb.).

Bürger (18th C.):

Was zwischen manchen wilden Haufen
Sich Bullius, der Aldermann,
An Hörnern endlich abgelaufen,
Das *läuft* sein Weib ihm wieder *an* (DWb.).

Attachment, in a sense, is implied in the following sentences.

Möser (18th C.): Herzoge, die über den ganzen sächsischen Heerbann *angesetzt* wurden (DWb.).

Thümmel (19th C.): Dass die Mannschaft sich schlafen lege, die nicht *angestellt* ist (S.).

The meaning 'to advertise', 'estimate', etc., arose from the practice of affixing notices of sale, valuation, etc., at some prominent place, usually on the door of the city hall.

Minnesinger (13th C.): eine Steuer *anschlagen* (L.).

Anton Tucher (16th C.): Solch Mulberck [Mühlwerk] hab ich *angeschlagen* pro 1470 Gülden (M.).

Luther (16th C.): Ich *zeige* meine Missethäter vor ihm *an* (Ps. 38, 19, DWb.).

If something is attached to an object the latter may increase in volume, as the following show.

Ayrer (16th C.): Der die Wasser *anlaufend* macht (DWb.).

Schweinichen (16th C.): Welche aus Quittung 144 Thaler *anlief* (S.).

Friedrich v. Logau (17th C.):

Er steht viel fester noch als feste eedem stehn,
Die Regen, Thau, Reif, Schnee, Frost, Hitze wird *angehn*.
(DWb.).

Goethe (18th C.): Torfflächen, die . . . sich nach und nach wieder ausfüllen und *anmachen* (S.).

Jean Paul Richter (18th C.): Im Ritter war das vertrocknete Bett des Lebens wieder reichlich *angequollen* (DWb.).

§ 157. The thing which is attached to another may be thought of as a burden placed upon another object. Of this the following quotations are examples.

Brant (15th C.): man *dut* wisheit kein ere me *an* (DWb.).

(Cf. Erlkönig—"Erlkönig hat mir ein Leid getan." [44])

Luther (16th C.): Ob sie wider dich streiten, sollen sie dir doch Nichts *anhaben* (Jer. 15, 20).

Thut inen die gebrandte Leid *an* (DWb.).

Und *kam* sie hart *an* über der Geburt (1 Mos. 35, 17).

§ 158. It has been pointed out before in this paper that one of the most prolific sources of semantic change was some connotation contained in a sentence of which the compound in question was a part. In the following quotations the purpose of the approach is of far more importance than the fact that an approach is made. The motive of the approach is a hostile one and the purpose is 'to attack'.

Tatian (9th C.): Thanân thô Zacharius uuard getruobit thaz sehenti inti forhta *anafiel* ubar inan (2, 4).

'Anafallan' is not thought strong enough to express the idea for the translator of Tatian, so he adds the preposition 'ubar', which has a force similar to the prefix 'über' in 'überfallen', whose semantic development is almost identical with that of such words as 'anfallen'. The next quotation from Tatian shows the force of 'anfallan', 'to attack', fully developed.

Tatian (9th C.): inti *ana gefiel* in thiobâ (128, 7).

Genesis (11th C.): nîdelîch *sprungen* si in *an* (M.).

Nibelungenlied (12th C.): ein ander *liefen an* Sîvrit der küene und ouch Liudegêr (213, 2).[45]

wart er *angerant* von drizec mannen (M.).

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[44] This force of burdening someone, of enchanting one, is contained in the simple 'tun' in the following sentence.

Minnesinger: diu süezen wort diu habent mir *getan*, daz ich nien kan gedenken wan an si alters eine.

[45] The preposition may likewise be used with this force:

Heinrich v. Veldeke: *an* die heiden er sie *hatzte* (M.).

Nibelungenlied: daz swin zornecliche *lief an* den küenen helet (938, 4).

In the last sentence 'an' may be either a preposition or a separable prefix. The close relation between the preposition and the adverbial particle is further shown by two quotations from Parzival:

ouch *grîfet* sîn (des Priesters) gewihtiu hant
an daz hoeheste pfant
daz ie für schult gesetzet wart (502, 17).

In the above 'angrîfen' merely means 'to take hold of', while in the following passage the meaning is 'to attack', that is, to take hold with the purpose of doing violence. Gawan threatens to lift Kamille upon his horse, and she says:

"uver unversichert hant mac *grîfen* wol *an* smæher pfant."

Walther v. d. Vogelweide (12th C.): sô rechet mich und *gêt* ir alten hût mit sumerlaten *an!* (DWb.)

Ludwigs Kreuzfahrt (12th C.): itslich her besunder dô sîne werc het und sîn ebenhô, als an driu teilen die stat wolden *an sturmen* sie (M.).

FIGURATIVE FORCE

Hartmann v. Aue (12th C.):

wan ez sint dri starke man
die mich alle *sprechent an* (Iwein 4086).

Luther (16th C.): Die Jünger aber *fuhren* sie *an* (Mat. 19, 13).

Hans Sachs (16th C.): Und *sprengt* den mit Worten *an* (DWb.). From the attack itself the emphasis is transferred to the result to the object attacked, namely, a state of exhaustion due to sustaining the attack.

Goethe (18th C.): Es *greift* sie zu stark *an*, liebe Lotte (16, 84). The attack may require an exertion of strength; from such connotation a meaning like the following has arisen:

Goethe (18th C.): Sie konnte fast nicht reden, doch *griff* sie sich *an* und sagte mit Schmerzen (5, 192, S.).

§ 159. Transferring the emphasis from the attack itself to the original position of the attacking party, the compound indicates a motion toward the thing to be attacked, that is, forward or onward.

Nibelungenlied (12th C.):

daz si deste balder kœmen über fluot
diu ros si *ane sluogen* (1571, 2).

Nürnberger Polizeiordnungen (14th C.): daz niemant den andern *annotten* sol weder des tages noch des nahtes âne ze hochzeiten (L.).

Bürger (18th C.):

Gehorchend *hieb* Saturnia
Die Rosse *an* (S.).

§ 160. To approach some one for purposes of begging or the like is also considered a form of attack.

Predigten des 13ten Jh.: waz *gât* mich und dich daz *an* (M.).

Luther (16th C.): Das man einen schwachen kranken Menschen in schwere Gefengnis legen sol und darnach auf solche trefliche Artikel so gehling zu respondiern *angelangen* (DWb.).

Ohne was sich sonst zuträgt, nämlich dass ich täglich werde *angelaufen* und trage Sorge für alle Gemeinden (2 Korinther 11, 28).

Sebastian Frank (16th C.): Einen *ankehren* ('sich an ihn wenden', S.).

Ayrer (17th C.): Derhalb wo unter uns ein Mann schon *anlangt* umb ein Jungfrau (DWb.).

Lessing (18th C.): Burleigh und Raleigh *treten* sie (Königin) um Erlaubnis *an* (DWb.).

§ 161. If one approaches an object, stopping when one reaches it, the force contained in the verb is that of arrival at (ankommen). If, however, the impetus is greater than that required just to reach the surface of an object, the impact is likely to be of a more or less violent nature, depending upon the force indicated by the verb in a particular sentence. Such is the force of the following compounds, 'an' adding to the simple verb the idea of 'against'.[46]

Hartmann v. Aue (12th C.):

> nû hienc ein tavel vor dem tor
> an zwein keten enbor
> dâ *sluoc* er *an* daz ez erhal (Iwein 301).[47]

Stretlinger Chronik (15th C.): . . . und *klopfet an* als ein bilger (24, 5).

Brant (15th C.): ich bin gar oft *gerennet an* (DWb.).

Luther (16th C.): Müssen sie (die Bösen) *anlaufen* und fallen (Ps. 27, 2).

Da fürchten sie sich, sie würden an harte Örter *anstoszen* (Apost. Gesch. 27, 29).

W. v. Humboldt (18th C.): (Dass das Schiff) am Felsenriff nicht *angeschleudert* scheitert (DWb.).

Gotthelf (19th C.): Die Rosinante musste . . . *angefahren* haben (S.).

§ 162. One of the earliest specializations of 'an' indicating a contact with an exterior surface, was developed in reference to the human

[46] This force is also shown by the preposition:

Walther v. d. Vogelweide: Ich *slüege* die gougelbühsen *an* daz houbet din (M.).

[47] From the figure of striking a drum or strings of an instrument and thus causing a response by the instrument, the following sentences may be explained.

Klinger: Das Weib gleicht einer Flöte, die jedem Töne gibt, der sie *anzublasen* weisz (DWb.).

Müller-Guttenbrunn: Pater Istvan Michlbach *schlug* jetzt einen anderen Ton *an* (Glocken 130).

body, that which came into contact with the body being clothes, armor, and weapons.

The quotations from Iwein and Parzival show this meaning contained in the preposition.

Hartmann v. Aue (12th C.):

die marter und die arbeit
die sî *an* sich selben *leit*
die solt ich billîcher enpfân (Iwein 1666).

Wolfram v. Eschenbach (13th C.): den (mantel) *legt an* sich der wol gevar (Parz. 228, 10).

Wie *bringe* ichz (daz harnasch) *ab* im unde *an mich* (Parz. 156, 17).

As is seen from the above quotations, the subject and the object of the preposition were the same person. In a sentence like, "den (mantel) *legt an sich* der wol gevar," 'sich' in time came to be omitted as superfluous (cf. § 81). The result would be, "den (mantel) *legt an* der wol gevar." When the group 'an + legen' had become specialized to refer to putting on clothes, the use was readily extended to sentences in which the subject and personal object (originally object of preposition), might be different persons.

Hildebrandslied: *gurtun* sih iro suert *ana* (5).

Otfried (9th C.):

bisah si thaz seltsana giuuati,
thaz thar uuiht ni rometi,
so er sih iz *analegiti* (4, 29, 37).

Genesis (11th C.): dâ nâch er in *ane warf* einen slâf (M.).

König Rother (12th C.): desse shô saltu mir *zien an* (M.).

Wirnt v. Gravenberg (13th C.):

zwô scharlaches hosen *streich* er *an*
mit flize an diu bein (DWb.).

Das alte Passional (13th C.): dar nâch êrlîch sich *an tet*, als ein biscof zu rehte sal (M.).

Teuerdank (16th C.): Tewrdank legt sich in sein Zeug—*anlegte* sein Turnierzeug *an* (A.).

This sentence is interesting as showing that the author did not feel that 'in sein Zeug' nor 'anlegen' alone, were sufficient to express his idea. In the following the indirect personal object is omitted.

Notker (10th C.): die harrun *tragen* sie *ana* (Ps. 34, 26, DWb.).

Lamprecht (12th C.):

si *hânt* lützel umbe und *ane* (M.).
tût ane uber sarwât (DWb.).

Hartmann v. Aue (12th C.):

und wâren ir in den stunden
ir cleider von ir getân
und niuwan ir hemde *an verlân* (Iwein 5154).
er *truoc an* seltsæniu kleit
zwo hiute het er angeleit (Iwein 465).
ein schalaches mäntelîn
daz *gap* sî mir *an* (Iwein 327).

Wolfram v. Eschenbach (13th C.): sîne *fuorte* niht wan knoden *an* (Parz. 257, 14).

§ 163. At a very early period the particle 'an' gave to the compound of which it formed a part, the meaning 'to begin an activity'. This is one of the most common meanings of verbs compounded with 'an' today.

In the following quotations the force of 'anafahan' is identical with the figure used in the English phrase 'to take hold of a thing' (a problem). The taking hold is the initial step of carrying out an activity.[48]

Otfried (9th C.):

haben ih zi klagonne, ioh leidalih zi sagenne,
ni uueiz ih, les! in gahe, uuar ih iz *anafahe* (5, 7, 24).

Lamprecht (12th C.): waz si mohten *ane gân* (M.).

Heinrich v. Melk (12th C.): sô der *grîfet an* geistlich leben (M.). Altho 'an' in the preceding passage may be either a preposition or an adverbial particle, the force of the group 'grîfet + an' is 'to begin'.

Hartmann v. Aue (12th C.):

unz daz diu naht *ane gienc* (Iwein 7347).
die zwêne ungefüegen man
die *huoben* in den strît *an* (Iwein 6718).

Wolfram v. Eschenbach (13th C.):

dô *huop* mîn hêr Gâwân
an der eldesten zem êrsten *an*
sus sprach er . . . (Parz. 672, 5).

This last is the most common use of 'anheben' in New High German.

Luther (16th C.): Küsset den Sohn, denn sein Zorn wird bald *anbrennen* (Ps. 2, 12).

Later the meanings of these compounds expanded to include the whole of an activity.

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[48] That the simplex might also express the idea 'to begin' is shown by the following Middle High German sentences:

daz gesinde *huop* grôzen schal (Iwein 1225).
Cunnewâr daz êrste weinen *huop* (Parz. 319, 12).
ein niuwez (spiel) *heben* (Gr. Rud. C. 12 per M.).

Fastnachtspiele (15th C.):

des wil ich ewern rat haben dazu
wie wir dem sollen thun,
das wir das auf das best *antragen* (9, 15, 24).

Luther (16th C.): So müsse dich auch ein gut Jar *angehen!* (DWb.)
Sonst wo man solch gebet imerzu umb ein sach *antreibet*, ists ein Zeichen, . . . (DWb.).

While in the above the verbs show that an activity has been begun, and will presumably be carried to completion, the following sentences contain verbs which indeed denote the beginning of an act, but they indicate that the activity may not be continued.

Minnesinger (13th C.): wenne ir *bîzt* an der spîse *an* (M.).

Canitz (17th C.): Bei zween von Amorn *angeschosnen* Leuten (DWb.).

Goethe (18th C.): Mit einer kaum *angeschriebenen* Feder (4, 183).

Jean Paul Richter (18th C.): Dasz er dem Arrestanten den Ring und den Ducaten wieder abjagte, die Beide zum Glücke weder versoffen waren noch *angefeilt* (DWb.).

Waldau (19th C.): Sie *brechen*, da ihnen grünes Holz abgepfändet wird, die Äste *an*, so dasz sie vertrocknen müssen (S.).

§ 164. The meaning 'to instruct' contained in such verbs as 'anweisen', etc., is arrived at by the following process:—By leading a person up to an object, he becomes acquainted with it, that is, acquires a knowledge concerning it. By a similar psychological process the type 'anweisen' acquired the meaning 'to instruct'.

Lieder d. 12ten u. 13ten Jh.: er *wîste* sîn vihe *an* di guoten weide (M.).

In this sentence is shown the starting point of the change further developed in the following sentences.

Rudolf v. Steinach (13th C.): da *wîste* gotes wort mich *an* (M.).

Luther (16th C.): Verstehst du auch was du lisest? wie kan ich, so mich nicht jemand *anleitet?* (Apost. Gesch. 8, 30.)

Fischart (16th C.): Zu rechter weis *anführen* (DWb.).

Stumpf (16th C.): S. Benedikts Regel, nach der er erstmals die Brüder reformiert und *anreiset* (S.).

§ 165. Closely related to such verbs as 'anhängen', etc. (§ 156), are those having acquired the meaning 'set fire to', 'ignite'. How this arose may still be seen from the use of the preposition 'an' in the first two of the following sentences.

Herbort v. Fritslar (12th C.): Als man daz vür ***darane stach*** (DWb.).

Mai und Beaflor (13th C.): die kameræere ***stacten*** diu lieht ***an*** die wende (M.).

Gottfried v. Strassburg (13th C.):

> dô kam diu rehte minne,
> diu wâre fiuræerinne
> und *stiez* ir sene fiuwer ***an*** (Trist. 929).

Wirnt v. Gravenberg (13th C.): daz viuer *warf* si in [eum] ***an*** (M.).

Das alte Passional (13th C.): wand er daz korn hete ***an geleit*** (M.).

Hermann v. Fritzlar (14th C.): liz Rome an vir enden ***an stecken*** zu burnende (Deut. Myst. 1, 148, 7).

Pfarrer v. Kalenberg (15th C.): doch ***macht*** ich ***an*** ein feür vil frisch unter die heffen an dem hert (1081).

Luther (16th C.): Denn das fewr ist ***angegangen*** durch meinen Zorn (5 Mos. 32, 22).

Fronsperger (16th C.): vil weniger sol einer oder der ander das Lager ***anfewren*** od verbrennen (DWb.).

§ 166. An object may be brought to a person for the purpose of giving him possession of it.[49]

Wirnt v. Gravenberg (13th C.): ein grafschaft, diu ist sîn; die ***brâht*** in sîn vater ***an*** (M.).

Das alte Passional (13th C.): der name si *an trat* von einer grôzen houbstat (M.).

Weisthümer (15th C.): daz er das gut nit ***an langt*** mit recht (M.).

J. H. Voss (18th C.):

> Für eine Tonne Weizen
> ***Schafft*** sich ein neuer Flausrock *an* (DWb.).

Tieck (19th C.): Dasz sich die Tochter doch wol irgend einmal einen reichen, angesehenen Mann ***antanzen*** würde (DWb.).

The acquisition may be mental or ethical as in the following sentences.

Hartmann v. Aue (12th C.):

> waz töhte ob ich mich selben trüge?
> swaz êren ich mich ***anzüge,***
> sô hânt sî alle doch gesehn
> waz under uns ist geschehn (Iwein 7574).

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[49] In Gottfried v. Strassburg's Tristan, the prepositional phrase shows this force:

"seht, daz hât iuwer vater Kanêl ***an*** iuch *geerbet* unde brâht" (5193).

Gottfried v. Strassburg (13th C.):

> frouwe, ez enist kein man,
> der sich hier umbe iht ***nimet an***
> und mich von mînen êren
> mit valsche wænet kêren (Trist. 9960).

Goethe (18th C.): Nach meinem ***angebornen*** und ***angebildeten*** Realismus (22, 200).

Wer mit Angewohnheiten des Dialekts zu kämpfen hat, suche das neu *Anzuübende* recht scharf auszusprechen (44, 297).

Devrient (19th C.): So trat er endlich mit der Gestalt, die er sich ***angelebt*** hatte, vor das Publikum (S.).

The various meanings of 'annehmen' may be treated in this section.[50]

Hartmann v. Aue (12th C.):

> uns ist ein gebot gegebn
> daz sich hie vor wîp noch man
> *nem* deheinen gast *an*
> ûzerhalp dem bürgetor (Iwein 6146).

Gottfried v. Strassburg (13th C.): waz hâst du dich ***angenommen?*** (Trist. 11326.)

Rudolph v. Steinach (13th C.): der sich ***nam*** sines râtes ***an*** (M.).

Luther (16th C.): Das ir euch umb die Redekunst so ernstlich ***annemet*** (DWb.).

Hagedorn (18th C.):

> Die Ziege hört des Hasen Klagen
> Mit *angenommner* Traurigkeit (DWb.).

Goethe (18th C.): Ihre Freude ist stark, sie ***nimmt*** die Gestalt des Schreckens ***an*** (17, 306, S.).

Klinger (18th C.): *Nimm an,* ein Zaubrer brächte dir den Wunderstein (DWb.).

'Anbieten' merely denotes an earlier phase of a transaction contained in the meaning of 'annehmen', etc.

Hartmann v. Aue (12th C.): dô *bôt* in der wirt ***an*** sine tohter (Iwein 6800).

Fastnachtspiele (15th C.): heur *trug* man mir ain altsz weib ***an*** (702, 12).

§ 167. The force of the verb compounded with 'an' meaning 'to stop at', 'to land', etc., requires no further explanation.

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[50] As in most of the meanings treated, 'an' as a preposition seems to be the starting point of the new development.

Walther v. d. Vogelweide: mich hât daz rîche und diu krône ***an*** sich ***genomen*** (M.).

Nibelungenlied (12th C.): Ze Misenburc der rîchen dâ *sciften* si sich *an* (1377, 1).

Luther (16th C.): Kamen in das Land Genesareth und *fuhren an* (Marc. 6, 53).

Sebastian Frank (16th C.): Unsre Schiff möchten *angeen* etwa an einen Schrofen und Felsen (DWb.).

S. F. Hahn (18th C.): A. 852 *setzten* die Normanen mit 252 Schiffen wiederum in Friesland *an* (DWb.).

Klopstock (18th C.): Endlich sinket sie ihm aus einem Nachen, der *antreibt*, an das schlagende Herz (DWb.).

Gerstäcker (19th C.): Als ob wir die chinesische Küste *anlaufen* wollten (S.).

§ 168. Compounded with certain verbs the prefix 'an' gives to the compound the idea of an upward motion. This force, however, is not contained in the prefix but in the simple verb itself, or it is derived from the context. The double prefix 'hinan' is now generally used in this sense.

Gottfried v. Strassburg (13th C.):

sus swebten sîne sinne in einer ungewissen habe:
trôst *truog* in *an* und zwîfel *abe* (Trist. 890).

Avanturier der Leipziger (16th C.): zu so einem *ansteigenden* vermögen gelanget (DWb.).

Goethe (18th C.): Der höher *anstrebende* Geist, das Geschick seinen Lehrer an Zierlichkeit und Zartheit zu übertreffen (DWb.).

J. H. Voss (18th C.): Des *hochanschwebenden* Adlers (DWb.).

Schiller (18th C.): Nicht für möglich acht' ichs—so gar steil *geht's an* (S.).

Jean Paul Richter (18th C.): Da der Hügel am höchsten *anlief* (DWb.).

Görres (19th C.): Zum Himmel *toste* ihr Kriegsgeschrei *an* (S.).

§ 169. As in the case of the compounds treated in the previous chapters, a number of verbs compounded with 'an' have become specialized thru their frequent use in certain trades, professions, etc.

Nibelungenlied (12th C.): sît *truogen an* die helde daz si ze wibe nam Giselher (1679, 3).

Gottfried v. Strassburg (13th C.):

sô wart daz schif *gestôzen an,*
alsus sô vuoren sî von dan (Trist. 1581).

Mühlhausener Rechtsbuch (13th C.):

anwîsit abir he [macht anspruch]
ûffi dechein gût mê (M.).

Monumenta Zollerana (13th C.): Geld *anlegen* ('auf Zinsen anlegen', L.).

Fragment (M. H. G.): kuochen mit rufolk *anslagen* (M.).

Scherzii glossarium Germ. medii aevi: ein guot *an varn* ('es in Besitz nehmen', M.).

Nürnberger Polizeiordnung (14th C.): die angiezzer suln ir mâze mit in tragen in ainem sacke und sie suln *angiezen* vor dem kelr oder in den strâzen, swâ in daz trinken begegnet (L.).

Pauli (16th C.): Mit seim Knecht het ein Wirt *angelegt,* welches weins er in hiesz bringen, so solt ers nit thun er geb im denn ein Warzeichen (DWb.).

Hohenheim (16th C.): Das flüchtige Metall, als Gold und Silber, von den Erzen zu scheiden, welchs die Bergleut *angeflogen* nennen (DWb.).

Seuter (16th C.): *Anraichen* ist anders nichts als wann sich ein Pferd mit den hindern Füeszen in die vordern tritt oder schlegt, welches ein gefahrlich ding (DWb.).

Zingkgraf (17th C.): Die Rede gieng, dasz er einer Damen ein Kind *angestellt* hatte (DWb.).

Spee (17th C.): Verklagt und heftig *angebracht* (DWb.).

Wie gefährlich es sei, mit der Welt sich *anzulegen* (DWb.).

Olearius (17th C.): Obschon ein Spiegel anlauft, wenn man ihn *anhaucht* (DWb.).

Weckherlin (17th C.):

Will er doch den Hof ganz zwingen,
Basen, Vätter, Esel, Freund,
Dieb und Kuppler hoch *anbringen* (DWb.).

Steinbach (18th C.): Das Bier *bricht an* ('wird faul', A.).

Hagedorn (18th C.): In Spanien *geht* dieser Fuszzwang *an* (DWb.).

Goethe (18th C.): Grosze Strecken sind mit Weiden und Pappeln *angeflogen* (28, 9).

Uebrigens schien der Unterricht nur auf Prellerei *angelegt* (20, 176, S.).

Kein Mann auf den sie's *angelegt,* hatte sich verwahren können (25, 3).

Sie werden zu Johanni reif, dann *setzt* der Baum noch einmal *an* (23, 352, S.).

J. v. Müller (18th C.): Sie wurden zu 7000 Gulden Kriegskosten *angelegt* (S.).

Schiller (18th C.): Auf das Haupt des Kindes *anzulegen* (S.).

§ 170. The word 'anwünschen', 'to adopt', is a literal translation from the Latin 'adoptare'.

Oberlinus: *angewunschene* Kinder (M.).

§ 171. The use of 'an' has become much restricted since Middle High German times, both as a preposition and as a prefix, some other preposition or prefix frequently being substituted in Modern German.[51] In Gothic the feminine noun 'analageins' (< analagjan) occurs with reference to laying on of the hands, as in blessing or healing a person. Now we should say, "die Hände auflegen."

AUF now preferred.

Tatian (9th C.): *legetun* irô hant in then heilant *ana* (184, 6).

Her thô arstantenti sliumo fora in nam thaz thâr her *analag* inti gieng in sîn hûs mihhilôsônti got (54, 8).

Inti mittiu *anasazta* in sînô hentî, gieng thana (101, 1).

Hartmann v. Aue (12th C.):

an ein daz schoenste gras
da *vuorte* sî mich *an* (Iwein 336).

Monumenta Habsburgica (15th C.): die juden sollen ir geltbrief ieden gelter *annotten* (L.).

Pauli (16th C.): Zu essen *antragen* ('an den Tisch', DWb.).

Luther (16th C.): Die Elephanten mit rothem Wein und Maulbeersaft besprützen, sie *anzubringen* und zu erzürnen (1 Macc. 6, 34, DWb.).

Wolan, so *nimm* es *an* mit meinem Herrn (Es. 36, 8).

Fischart (16th C.): also ward Gargantua *angezogen* und guberniert (DWb.).

Goethe (18th C.): Er war keinesweges schmeichelnd und *andringend,* das machte mich sorglos (19, 105).

[51] Hartmann v. Aue says: "Ein ritter der gelêret was und ez *an* den buochen las" (Iwein 21), where it would now be necessary to say: "in den Büchern." Cf. also: "Er woltez (Kind) nimer lazen, und nam ez *an* den arm" (Wolfdietrich B. 169, 1).

Sagt im ze wortzeichen, er wizz wol waz er mir riet
des nahtes *an* dem bette, do er des morgens von mir schiet.
(Wolfdiet. B. 215, 4.)

an got vom himelriche unser beider leben stat (Wolfdiet. D. 100, 1).

Gervinus (19th C.): Einem seine eignen Empfindungen unter- und *anschieben* (S.).

AUS.

Luther (16th C.): Dasz arme Gesellen in dieser schweren Zeit mit solcher Besoldung, wie zu Braunschweig, nicht mögen *ankommen* (DWb.).

Ayrer (17th C.):

Ach solt mich der Fürst *setzen an*
dem ich hab so vil guts gethan? (DWb.).

BEI.

Wolfram v. Eschenbach (13th C.):

junchêrre, komt ir in des [König Arthur] hûs,
der *bringet* iuch *an* riters namn (Parz. 123, 8).

EIN.

Nibelungenlied (12th C.): ze Misenburc der rîchen dâ *sciften* si sich *an* (1377, 1).

Gottfried v. Strassburg (13th C.): diz *truog* in grôzen jâmer *an* (Trist. 2583).

Das alte Passional (13th C.): daz si an ieglîcher stat bewiseten die sie *an trat* (M.).

Luther (16th C.): man musz uns *ansingen* und *anblasen*, das wir den Herrn sollen preisen (DWb.).

Dieweil der Türk dieser Zeit an viel Orten *anbricht* und der Christenheit groszen Abbruch thut (DWb.).

Sebastian Frank (16th C.): An etlichen Orten verjahen [bekannten] dis die Juden darumb *angezogen* und gefoltert (DWb.).

Hahn (18th C.): Von den vielen Competenten, die nach Henrici Tode sich zum Kaiserthum *angefunden* (DWb.).

INNE.

Otfried (9th C.): ther gotes geist, ther mo (dem Symeon) *anauuas*, ther gihiaz imo thaz (1, 15, 5).

§ 172. Finally there are a few older compounds with 'an' in which the prefix is superfluous according to our modern speech sense.

Gottfried v. Strassburg (13th C.): sô *trîbe* wir vil harte unnütziu teidinc *an* (Trist. 6832).

Fastnachtspiele (15th C.):

mit singen und mit saitenspil
das sie *antreiben* dick und vil (735, 17).

Luther (16th C.): Wie er sol Herr Leonharten gefenglich *annemen* (DWb.).

Sebastian Frank (16th C.): Wann man meint, si seien schon erlegen, und erschlagen, so ist in erst recht *angeholfen* (DWb.).

Fischart (16th C.): Nach disem Fürbild solt ihr euch weislich wissen ***anzustellen*** (DWb.).

Opitz (17th C.): Die Zeit, welche dazu nicht ***anreichet*** (DWb.).

Jean Paul Richter (18th C.): Er wurde von den Ideen entweder angepackt oder gar nicht *angestreift* (S.).

Part III.

'Heran' and 'Hinan' with their Original Force

§ 173. 'Heran' was the last of the double prefixes to develop, the first records occurring in the 17th century. The particle 'an' by itself denotes 'proximity to an object' or motion to such a position. When the speaker identifies himself with the object the direction of the motion indicated by a verb compounded with 'an' is obviously toward him. Hence the demonstrative 'her' is superfluous and was added only as an intensifying element in analogy to other compounds with 'her'.

'Hinan' occurred as early as Old High German, but the force is rather vague.

Otfried (9th C.): *îlêmês* io ***hinana,*** uuir fuarun leidor thanana (5, 23, 99).

zi theru burgi *faret* ***hin ana*** (1, 12, 19).

In the first sentence 'hin' would suffice, in the second 'hinîn' would seem more accurate.

The next two sentences contain the preposition 'an' and the demonstrative 'hin' still considered as independent words.

Wirnt v. Gravenberg (13th C.): *leit* in ***an*** daz schif ***hin*** (M.).

Minnesinger (13th C.):

die stige sint mir abe getreten
die mich ***leiten hin an*** dich (M.).

Statistics on the Spread of 'Heran' and 'Hinan'

	'HERAN'	'HINAN'	TOTAL
Old High German period	—	2	2
Middle High German period	—	—	—
15th Century	—	1	1
Luther	—	7	7
17th Century	11	4	15
Goethe	28	6	34
Rest of 18th Century	24	23	47
Campe	90 (15)	34 (5)	124
19th Century	8	5	13
	161	82	243

§ 174. 'Her' is sometimes prefixed to 'an' when the latter has the meaning 'to attach to'. (Cf. § 156.)

Campe (19th C.): ***heranfeilen*** = vermittelst der Feile heranbringen.

heranschleifen = durch Schleifen heranbringen.

heranschmieren = durch Schmieren, als eine Schmiere heranbringen.

heranschreiben = an diese Stelle herschreiben.

Part IV.

New Meanings Developed by 'Heran' and 'Hinan'

§ 175. As the compounds with 'heran' and 'hinan' are of such recent formation, it is not to be expected that they have assumed many new functions. Both double prefixes are frequently compounded with verbs denoting an upward motion, which they intensify. This is especially true of 'hinan'.

Logau (17th C.):
Klug, an Hirne
Schön, an Stirne
Bringt den Mann
Hoch ***hinan*** (DWb.).

Stieler (17th C.): Den Berg ***hinanreiten*** (DWb.).

Steinbach (18th C.): Bis an den Himmel ***hinanheben*** (DWb.).

Hoch ans Brett ***hinankommen*** (DWb.).

Gellert (18th C.): Er ***sah*** bald in das Thal und bald den Berg ***hinan*** (DWb.).

Goethe (18th C.): Als ich die neue Strasse ***hinanfuhr*** (DWb.).

Nur die technisch höchstgebildeten Völker ***reichen*** an jene ***hinan*** und übertreffen sie in Vielen (S.).

Wir ***steigen*** die Dole ***hinan*** (16, 234).

Sie ***zog*** mich zur Erd' ab, zum Himmel ***hinan*** (S.).

Stollberg (18th C.): Wie von einer Stadt der Rauch den Himmel ***hinanwallt*** (S.).

Schiller (18th C.): Groszer Thaten herrliche Vollbringer ***klimmten*** zu den Seligen ***hinan*** (DWb.).

Jean Paul Richter (18th C.): Wenn das Auge ***hinanstrebt*** in die ewigen Räume (DWb.).

Gökingk (18th C.): Ich ***kletterte*** den Baum hinan (DWb.).

§ 176. 'Heran' is often prefixed to verbs indicating a 'growth', 'development'. The idea of 'growth' is present in the simple verb, the prefix denoting an approach toward the level of the speaker or something which he has in mind.

Rabener (18th C.): Und wenn die Fräulein ja heirathen will, so wird ihr der Oberste schon einen feinen vernünftigen Mann aussuchen, der in seinen besten Jahren ist, und die gute junge Fräulein vollends *heran ziehen* kann (DWb.).

Goethe (18th C.): Und so erfuhr ich auch hier bei einiger Nachfrage gar leicht, dasz von Dietrich . . . sich zu einem immer wachsenden Wohlhaben *herangearbeitet* habe (25, 331).

Ehe ich, . . . nach Hause kam, war das Stück (Clavigo) schon ziemlich *herangedacht* (26, 350).

Müssen wir auf das Herkommen, auf das *Herankommen* dieser schon zu hohen Jahren gelangten würdigen Person unsere Aufmerksamkeit richten (21, 120).

Sie (meine Schwester) . . . hatte mein ganzes bewusztes Leben mit mir *herangelebt* (25, 20).

Es (ein Buch) fordert uns auf, in das Allgemeinste, . . . unser Schauen hinzuwenden, und von da die Völkerschaften nach und nach zu unserm Blick *heranquellen* zu lassen (45, 407).

Schon zum voraus erkannte er was die neuen *heranstrebenden* Pflanzungen versprachen (17, 316).

Mit dem Wachsthum des Knaben, der sich wirklich zum Jüngling *heranstreckte* (22, 153).

Das Kind *übt* sich im Leben an den irdischen Dingen selbst *heran* (25, 119).

Ein so schön *heranwachsendes* Mädchen (S.).

Wieland (18th C.): Das die Welt zu einer grossen Revolution *heranreife* (S.).

J. H. Voss (18th C.):

Die noch aus Staub allmählig keimend
Zu paradiesischer Blum' *heranblühn* (C.).

Prutz (19th C.): Er hatte sich den Heinrich speciell zu seinem Leibdiener *herangezogen* (S.).

Müller-Guttenbrunn (20th C.): Genau so wie der Bischof v. Temesvar, der ein geborner Schwabe war, madjarische Kleriker zu Hunderten *heranbildete* (Glocken 60).

§ 177. In the following quotations 'hinan' shows the beginning of specialization.

Luther (16th C.): Es steht aber dabei, das die Christen uber solchen Sieg müssen ir Leben ***hinan setzen*** (DWb.).

Herder (18th C.): ***hinanwachsen*** = fort wachsen (S.).

Arndt (19th C.): Hier ward ich also sogleich, wenn nicht mit hineingestellt, doch ***hinangestellt,*** und habe für die Bestimmung . . . der deutschen Legion manchen Dintentropfen aus der Feder lassen müssen (DWb.).

SUMMARY

§ 178. A summary of the fifth chapter follows.

1). Unlike the particles treated in preceding chapters, 'an' had a prepositional function since the time of its earliest records. As such, and later as an adverb, it denoted 'proximity to' or 'contact with' an object or motion to such a position.

2). Nearly all changes of meaning can be traced to one or the other of these two functions.

3). Frequently the particle seems to have arisen in an elliptic sentence, 'an' originally being a preposition whose object was omitted.

4). Both 'an' and 'her' indicate an 'approach', usually to a place with which the speaker identified himself. Hence, 'her' of 'heran' is superfluous. It does not occur until the 17th century, and then probably as a result of analogy to other compounds with 'her'.

5). 'Hinan' occurs as an adverb in Old High German, but no records were found for Middle High German.

6). There are nearly twice as many verbs compounded with 'heran' as with 'hinan'.

LELAND STANFORD JUNIOR UNIVERSITY PUBLICATIONS
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as illustrated by thirty-two consecutive cases

BY

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(Continued on third page of cover.)

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TO ALL THOSE WHO CONTRIBUTED IN THE COLLECTION OF THE CLINICAL DATA UTILIZED BY THE AUTHOR

THE PATHOLOGY OF NEPHRITIS

AS ILLUSTRATED BY THIRTY-TWO CONSECUTIVE CASES

It may seem presumptuous on the part of a pathologist to attempt to write a treatise on the Pathology of Nephritis including a résumé of the symptomatology of the disease, because the evidence collected from the histories of the patients is necessarily second-hand and incomplete and the author is not trained in the interpretation and evaluation of clinical phenomena. It may be contended, however, that the careful judicious contemplation of a clinical history by some one not connected with the case and not interested in the matter of clinical diagnosis—provided he has the necessary knowledge of Medicine in general—may bring out the salient points in the biology of the disease with greater clearness. However that may be, since it became necessary to consult the records in trying to solve the etiological questions involved, an attempt has been made to give an outline of the progress of the disease in each individual case as briefly as possible, without entering into any of the many details that are chiefly of clinical importance.

The aim has been to collect in each case all relevant data which might have any bearing on the etiology, progress and termination of the disease.[1] To this was added an abstract of all autopsy findings which might be of interest, and an especially careful description of the findings in the kidneys, both in the gross and microscopically. Since no mere description in words can convey an adequate conception of the findings, photographs of the gross specimens have been added wherever feasible, and in all cases photomicrographs of the diseased kidneys. The latter, of course, reproduce only a very small area of the tissues examined; but an attempt has been made to show as much as possible without

[1] The results of functional tests have not been considered, with the exception of an occasional reference to the phenolsulphone-phthalein test. This has been done, not because their great scientific interest and practical value is not fully recognized, but because many cases antedated the use of such functional tests, so that the evidence in the few recent cases is hardly sufficient to warrant any deductions. An attempt to go into this question, in which all clinical workers at present are deeply interested, would also have opened up such a large field for discussion that it seemed wise to refrain from discussing it altogether.

losing all detail, and to select for reproduction as representative places as possible in the sections. The tissues were hardened in Orth's mixture and stained with haematoxylin-eosin, or according to van Gieson's method. In each case several sections were also stained with Weigert's stain for elastic fibers, and with Giemsa's stain for bacteria, and in order to bring out the characteristic granulations of the various leucocytes.

All photographs and photomicrographs are comparable with one another, since all photographs have been taken at about one-half normal size, and all photomicrographs at the same magnification (57 times natural size).

It is hoped that the cases as represented will speak for themselves. The comments which precede them serve the purpose of presenting some of the main facts in a readable manner, and also to draw such conclusions from them as may seem warranted.

The cases, in the opinion of the author, are all cases of true diffuse glomerulo-nephritis, and represent all such cases that were encountered in a consecutive series of about nine hundred necropsies. They are the same cases which were used in preparing the author's previous publication in the *Journal of the American Medical Association* in 1915, where a summary of the findings is given under the headings of acute, subacute, and chronic glomerulo-nephritis. It is unlikely that any case of importance escaped detection, because microscopic sections of the kidneys were examined in all nine hundred cases, and in the vast majority of instances personally by the writer. All cases of chronic parenchymatous nephritis with amyloid disease have been excluded, as also all cases in which the renal lesions were evidently of minor importance as compared with coexisting arterial disease.

For convenience' sake the main data of each case have been gathered in one large table, which is placed at the end of the volume.

A historical review of the subject is purposely omitted, because to cover this part of the subject adequately would consume much space—unnecessarily, it would seem, because the subject has been dealt with extensively and adequately by other writers. Since the author has previously attempted to present what appeared to him the main facts in the historical development of the subject, and has attempted to give due credit for previous work, he hopes to escape the imputation that he attempts to assume more credit than is due for his own efforts. In fact, the author specifically disclaims all credit to himself except that which may be due to the careful presentation of a series of case-reports. His comments are merely expressions of his personal opinion, and are based, naturally, not only on his own observations, but upon the splendid work

done by numerous investigators recently and during the course of the last century.

Since in teaching it is necessary always to go back to the sources of original information, a series of complete case-reports of one particular disease should be of great benefit to teacher and student. It would be especially gratifying to the author if this little volume should prove to be useful for teaching purposes.

I. Acute Glomerulo-Nephritis (Cases 1-4).

The first two patients were males of over 50 years of age, with old infectious endocarditis of the aortic orifice. According to the histories, and also according to the anatomical findings, the original infection dated back many years; in the first case, at least eight, and in the second altogether twenty years. The course of the disease in both cases was quite the usual one for chronic endocarditis, and the patients died in one of the exacerbations.

The nephritis in both cases was terminal and incidental to the main disease. In the first case it revealed itself clinically by very definite urinary findings, and by a slowing of the phenolsulphone-phthalein secretion. In the second case the urinary changes were very slight—so much so that the condition might very well have been overlooked clinically.

In both cases diplostreptococci were found in the lesions in the heart valves, and in the first case also in the urine, and in the spleen at necropsy.

The kidneys in these two cases were not as yet very much swollen; the cortex was somewhat opaque, the seat of petechial haemorrhages. The glomeruli showed the very earliest lesions: hyaline necroses of some of the loops, and a very marked infiltration with neutrophilic leucocytes. In case 2 there was some extra-capillary proliferation in the glomeruli, and a slight infiltration of the adjoining connective tissue with neutrophilic leucocytes. There had been much bleeding from the diseased glomeruli, and also escape of some leucocytes into the tubules. There were as yet few casts, and the epithelium was nearly unaltered.

In the case (1) in which the bacteria were found in the urine, no bacteria were found in sections of the kidneys either in the glomeruli or in the tubules; but there were many capillary diplostreptococcic emboli between the tubules, some with beginning suppuration about them. This is one of the cases which so strongly suggest that in glomerulo-nephritis coccus embolism does take place in the glomeruli, but that in these structures the bacteria are rapidly dissolved, in this way causing the hyaline thrombosis and necrosis of the vascular loops.

It is interesting to note that in both of these cases there were quite a few small foci of old *focal* nephritis, such as have been described in diplostreptococcus endocarditis by previous observers. This was also the case in observation 3. Evidently for many years the kidneys withstood the effect of continued bacterial embolism fairly well, until in the end they more or less suddenly gave way. It is difficult to say whether

this should be ascribed to an increased virulence on the part of the infectious organism or to the development of a hypersensitiveness in the organ. It appears to me that on the whole the last view is the more likely one.

The third case is remarkable because, in spite of the fact that an old endocarditis was found at autopsy, there were no clinical symptoms to suggest it. The fourth case is one of cirrhosis, with the usual clinical manifestations. In both of these last cases the acute nephritis developed in the last three weeks. In case 3 there was a very suggestive history of a sudden breakdown, with characteristic disturbances in urination three weeks before his death. The patient suddenly had to urinate very frequently, and developed oedema. In case 4 there is no such definite history of the onset, but about a month before her death she became much worse, this being some time after the development of septic ulcers on her legs, which were probably the cause of her nephritis. The nephritis in these cases is therefore probably about three to four weeks old. Clinically it showed by the development of oedema. Some puffiness of the face is recorded in case 4. The urine in both cases contained much albumin, many hyaline and granular casts, and some leucocytes.

The kidneys were greatly swollen. They were hyperaemic and oedematous. The cortex was wide, more or less yellowish, and opaque. It contained petechial haemorrhages. Histologically there was somewhat more evidence of extracapillary proliferation in the glomeruli; otherwise the lesions were similar to those observed in the earlier cases. Many tubules were filled with blood and with neutrophilic leucocytes. The epithelium was swollen, somewhat granular, and in one case fatty degeneration had occurred. The interstitial tissue in both cases was heavily infiltrated with neutrophilic leucocytes and with lymphocytes. In case 4 there was already evidence of a beginning proliferation of the connective tissue cells. That this proliferation was of inflammatory origin is so evident that it does not admit of any discussion. In some of the glomeruli also a beginning organization of the necrotic material had set in. In the one case in which the tissues examined were sufficiently well preserved for bacteriological examination no bacteria were found, in spite of long continued search with the mechanical stage through several sections.

In all four cases of acute glomerulo-nephritis the etiology was clearly evident. There was streptococcic infection with bacteriaemia in all, and in three the nephritis occurred in the final stages of an old diplo-streptococcic endocarditis. The death of these four patients is largely attributable to their pre-existing disease, and it was for this reason that

there was an opportunity of studying the alterations in the kidneys at this early stage.

In the very beginning the lesions are practically confined to the glomeruli, the initial change being a hyaline thrombosis of some of the vascular loops, followed by necrosis and an infiltration of the entire glomerulus with neutrophilic leucocytes. Naturally in ordinary sections not all affected glomeruli show the necrotic loops, but my impression is that in a series one can always find them in each affected glomerulus. The diseased glomeruli bleed and permit of the passage of albumin and leucocytes—which explains the material found in the capsular spaces, in the tubules, and in the urine. Sometimes the exudate has a tendency to spontaneous coagulation in the capsular spaces and in the tubules.

Very soon these glomerular lesions are followed by a general hyperaemia and oedema which causes considerable enlargement of the organ. The oedema often is very pronounced. The hyperaemic blood-vessels show a marked local leucocytosis, numerous venules in the region of the vasa recta being especially engorged and full of various types of leucocytes. The congestion is soon followed by a general extravasation of leucocytes into the tissues, the intensity of the reaction naturally depending on the severity of the process. Among the leucocytes that find their way into the tissues there are many neutrophilic cells, together with lymphocytes and plasma cells, as can easily be seen in sections stained with Giemsa's stain according to Schridde's method. The amount of epithelial degeneration also naturally varies with the intensity of the process. In some of our cases it is noted as slight, in others it is quite considerable. There is no question that the disturbance in circulation and the oedema as such must be important factors in the development of these degenerative lesions; still one can hardly escape recognizing also the importance of a toxic factor. The possible epithelial lesions at this time consist in swelling, with slight granular degeneration, fatty degeneration, and scattered necroses.

As a result of the inflammatory oedema the connective tissue cells of the interstitial tissue become swollen. After a few weeks, evidences of proliferation may be observed on their part. As has been stated above, of the inflammatory nature of this proliferation there can be no doubt.

In the glomeruli also proliferative changes occur quite early in the process. The capsular epithelium swells, is partly detached, and proliferates somewhat. My impression, however, is that the majority of the new cells in the glomeruli which become so plentiful in the later stages are derived from the connective tissue, both of the capsule and of the

stalk of the glomerulus. The proliferative process in the glomeruli also is partly distinctly inflammatory; in part, however, it is in the nature of an organization of the necrotic material produced, or of deposits of fibrin which are apt to occur in the capsular space.

Of the origin of the apparently initial hyaline thrombosis and necrosis of some of the vascular loops of the glomeruli, I have spoken at length in my previous article. Suffice it to state here that it appears probable to me that it may be due to rapid lytic destruction of bacterial emboli, with liberation of haemolytic and necrotizing endo-toxins.

The slight lesions in the larger arteries in the kidneys and elsewhere which are noted in the protocols, are naturally purely incidental.

I may state at this point that for brevity's sake in the protocols I have used the terms "arteriosclerosis" and "endarteritis" in the sense of Jores, employing "arteriosclerosis" when there was a notable hyperplasia of the elastic elements of the intima. The distinction, however, is meant to be a purely morphological one, not implying the deeper significance attributed to it by Jores.

II. Subacute Glomerulo-Nephritis (Cases 5-12).

Naturally, there exists no sharp line of division between the acute, subacute, and chronic cases. Cases 5 and 6, for instance, might just as well have been classified with the acute, and cases 11 and 12 with the chronic types.

The beginning and the course of the disease were very characteristic in case 5. The patient's trouble commenced with an attack of tonsillitis about nine months before she died. Soon symptoms of acute polyarticular rheumatism made their appearance, and continued intermittently for about six months. The severe endocarditis, which evidently developed simultaneously, was overlooked until the patient entered the hospital in the last stages of the disease. At that time she already showed evidence of severe renal involvement. It is not apparent from the history when her renal disease started. How far her oedema was associated with her nephritis is difficult to tell; but there are certain symptoms recorded in the history, like frequent vomiting, restlessness, drowsiness, muscular twitching, which arouse the suspicion of a uraemic condition. Her blood pressure, in spite of the severity of her renal complication, was not affected, possibly on account of the severe septic involvement of the heart muscle. Diplo-streptococci were recovered during life from blood and urine, and after death from the infected heart valves.

The following case (6) is an interesting one on account of the fact that the infection which caused the nephritis was apparently caused by colon bacilli, no evidence of streptococcus infection being discovered either during life or at necropsy. On account of the fact that the child had congenital syphilis, it might be suggested that the lesions in the kidneys also were of syphilitic origin; but so long as we know so little of the histology of acute and subacute syphilitic nephritis, I believe we would hardly be warranted in making this assumption. In other words, I do not believe that the proof has yet been furnished that spirochetes can produce lesions in the kidneys similar to those observed in ordinary bacterial infections.

The next case (7) is a good example of how inattentive some patients are to the state of their health. The first symptom that attracted this patient's attention was a hemiplegia and aphasia as a result of embolism from a severe diplostreptococcus endocarditis. The urinary findings were unusually slight for the severe lesions in his kidneys. Except for the general oedema, which of course may be attributed to his cardiac disease, there were no other general symptoms of nephritis.

In patient 8, who had an old streptococcus infection of a compound fracture of the leg, the urinary findings made the diagnosis of nephritis evident. There was some oedema, but it was not very marked at any time. Other "nephritic" symptoms were completely absent, in spite of very severe lesions in the kidneys.

In case 9 the renal disease was only a minor incident in the typical clinical development of a severe septic endocarditis, probably arising eight months before death from infected wounds on the fingers. Still, the urinary findings were unmistakable and the phenolsulphone-phthalein excretion was distinctly slowed. Three months before his death the patient had noticed some oedema at the ankles, increased thirst, and increased urination. The oedema at no time was a prominent symptom, and was absent at death.

Case 10 is noteworthy in several particulars. The patient, a young woman, had had an unusually severe long-continued infection, developing from a decayed tooth about one year before her death. An abscess eventually formed at the lower jaw which had to be drained from the outside. Following the operation the abscess healed, and at necropsy a small scar only could be found at the place where it had been. Several decayed teeth, however, remained in her mouth. After the healing of the abscess she was apparently well until four weeks before her death, when she developed a painless oedema of the legs. Ten days later the right leg, which was still oedematous, became infected with streptococci, from which infection she died within a short time.

The histological picture of the lesions in the kidneys in this case differs from that of other cases of this series by the lack of evidence of actively progressive inflammation. The alterations were very extensive, but apparently not very severe, and almost quiescent. Almost all of the glomeruli were diseased. They showed development of fibrous tissue between the vascular loops, making the tufts thick and heavy. There was also some little proliferation in some of the capsules and in the capsular spaces. Although so many glomeruli were diseased, one did not receive the impression that the majority were functionally badly damaged. The newly formed fibrous tissue was found on the inside of the tufts, and did not therefore apparently interfere much with the secretion of the urine-water; and the vascular loops themselves, although some of them showed a slightly thickened hyaline wall, appeared otherwise normal. Many tubules were filled with hyaline casts, and some of them with neutrophilic leucocytes. The epithelial degeneration which was present in the tubules was probably recent, and to be attributed, at least in part, to the streptococcus sepsis from which the patient died. The

arteries were practically normal, except the main stems of the renal arteries, which were moderately sclerosed. On the whole, therefore, the histological picture would suggest that the process was fairly well healed, at any rate rather quiescent. Clinically, however, the evidences of renal disease were well marked. Her first symptom, the oedema, was evidently a "renal" oedema, because there were no signs, either clinical or anatomical, of cardiac decompensation. There was also distinct hypertension, and a slight but unmistakable hypertrophy of the left ventricle. The urinary findings also were well marked. Although the urinary production was diminished, the specific gravity was fixed at about 1010; there was much albumin in the urine, and many formed elements in the sediment. Symptoms of uraemia, however, were altogether absent.

In the following case (11) we have subacute nephritis in an individual suffering at the same time from old diplostreptococcic endocarditis and syphilitic aortitis with aneurysm. The time when the diplostreptococcus infection took place cannot any more be established exactly, but the patient complained of heart trouble for at least four years before his death. As shown by a history of extreme polyuria half a year before his end, his nephritis must have dated back before this time. The polyuria in this case was a striking and constant symptom, and possibly accounts for the comparative absence of oedema. His symptoms were largely those of endocarditis, complicated naturally by the co-existing aortic aneurysm. His blood pressure was high and rising. His heart was twice normal size, an enlargement partly due to aortic regurgitation. His urine, on account of the polyuria, naturally had a constant low specific gravity; it contained much albumin and many formed elements. While he was at the hospital there was practically no excretion of phenolsulphone-phthalein. The pericarditis which he developed eventually was due to an extension of the diplostreptococcic infection from the heart valves to the pericardium.

In the last case (12) the nephritis is evidently much older than in the others of this series. This patient had had numerous attacks of tonsillitis from infancy. Six years before death her nephritis had been first noticed. For the last five years she had had definite "uraemic" symptoms (headache and vomiting), and occasionally slight oedema. The most interesting feature in this patient's history was that she had associated with her nephritis what appeared to be typical symptoms of "Raynaud's disease," attacks of syncope and cyanosis in fingers and toes. Eventually she developed an anaemic (?) contracture of her left arm and a dry gangrene of her left foot. This symptom-complex was probably due to a gradual closing of her peripheral arteries by lateral thrombosis and endarteritis. Unfortunately we were not permitted to verify this sup-

position at autopsy; but we have evidence that her internal arteries, more especially those in the heart and kidneys, were gradually being closed by such a process. In both of these organs, as a consequence, small multiple necroses resulted, which in the heart were irregularly scattered, and in the kidney were situated in the pyramids. Bacteria were not found in the small arteries which were the seat of the thrombosis. Towards the end a similar thrombotic obstruction took place in some of the arteries of the sigmoid flexure, with much bleeding and extensive sloughing. All these processes naturally at first suggested the occurrence of multiple embolism; but no source of embolism was discovered in the pulmonary vein, left heart, or the aorta; besides, the gradual development of the conditions in the extremities speaks very much against embolism as the causative factor, and favors the idea of their origin by gradual thrombosis.

The case, I believe, is of unusual importance, because it seems to furnish the proof that the lateral thrombosis followed by endarteritis, which is so frequently observed in the kidneys in these cases of glomerulo-nephritis (see below), may involve arteries in other parts of the body, and may in this way give rise to symptoms resulting from a more or less gradual obstruction of them. No doubt sometimes the cerebral arteries may be involved in the same way. That this patient, in spite of the absence of an infectious endocarditis, suffered from a chronic diplostreptococcus bacteriaemia, at least as long as she was under clinical observation, seems evident. She had a septic temperature all the time. Her pulse rate varied between 80 and 130, and the blood culture was positive. In fact, clinically there seemed to be no doubt that the patient had a septic endocarditis, and the absence of this condition at autopsy was a great surprise. Unfortunately, a thorough search for another chronic septic focus could not be made. It is possible that in this instance the urinary tract itself may have harbored the diplococci, because there was evidence at necropsy of a slight chronic suppurative pyelitis and cystitis with positive finding of diplostreptococci. This, however, may have been merely the consequence of the constant elimination of diplostreptococci by way of the kidneys.

This patient's "nephritic" complications were unmistakable. She had headaches and vomiting; she had albuminuric retinitis; she had comparatively little oedema; she had a high blood pressure with clinical signs of excessive heart action, but without gross hypertrophy; she died in uraemic coma. The urinary findings also were very well marked. She had some symptoms suggesting polyuria, a fixed low specific gravity. The urine contained much albumin, and at times there were large showers of casts. Red blood cells were also commonly found.

To sum up: In all these cases of subacute nephritis, except in case 6, there can hardly be any question of the etiology; and in this one I am inclined to believe that the nephritis was due to a colon bacillus septicaemia arising from the infected urinary tract. In the cases with endocarditis (5, 7, 9, 11) chronic diplostreptococcus septicaemia existed, without doubt; in case 8 a chronic streptococcus septicaemia from the infected bone is also very likely; and in case 12 the clinical symptoms and the positive blood culture proved the existence of a chronic septicaemia, at least as long as the patient had been under clinical observation. The source of the continued infection in this case was possibly in the urinary tract. The only somewhat questionable case is case 10, where the original septic infection was present in the region of the jaw, where, however, after long treatment the lesion eventually healed. No persisting septic focus was definitely made out, although she still had several decayed teeth; and it is possible that the histological evidence of comparative quiescence of the process in the kidneys might indicate that whatever infection remained was not very active or extensive.

The clinical symptoms of nephritis were quite definite in all cases. All of them had oedema at one time or another, the amount of oedema and its distribution varying very much in different cases. One early case (5) had somewhat indefinite symptoms of uraemia; otherwise the others were free from it, except the most chronic case, which was much older than the rest, in which there were observed very definite uraemic symptoms and a well marked retinitis albuminurica.

Case 8, of about six months' duration, already showed a beginning hypertrophy of the left ventricle; and the last three cases had a definite rise of systolic blood pressure to between 170-200 mm. mercury, and two of them a noticeable hypertrophy of the left ventricle. In the case (11) with very marked hypertrophy of the heart, the hypertrophy was probably largely due to valvular disease.

The urinary findings were striking in all cases. The urine at all times contained much albumin. Casts (hyaline, granular and epithelial) were almost just as constantly present, although sometimes they were not found at all times, but in showers. Leucocytes and erythrocytes, either free or as blood casts, were also commonly encountered. Two cases (9 and 11) had a definite polyuria, which was extreme in case 11. In the more chronic cases (10, 11, 12) the specific gravity was fixed at a low point, not always apparently as a result of polyuria, the condition being suggestive of a true hyposthenuria.

In case 9 the phenolsulphone-phthalein excretion was somewhat slowed, in case 11 entirely suppressed, and in case 12 very much delayed.

In the gross, the kidneys were smooth, congested, oedematous and swollen, or already contracted to about normal size. The cortex was either diffusely opaque or contained small opaque spots. Petechial cortical haemorrhages were often seen. They were most numerous in case 5 (see fig. 7). Histologically, in the more acute cases the tissues were still much infiltrated with neutrophilic leucocytes, to which were now added many eosinophilic and basophilic cells. The glomeruli in most cases showed a very general intense intra- and extra-capillary proliferation. In the more chronic cases many of them had already become fibrous. The tubules were full of blood, neutrophilic leucocytes, and casts. The amount of degeneration in the epithelium of the tubules varied, being intense in some cases and rather light in others, without much reference to the severity of the lesions elsewhere. In all cases the interstitial tissue, in addition to being infiltrated with lymphocytes and granular leucocytes, showed evidence of considerable fairly diffuse, inflammatory proliferation, which in the later stages had already commenced to encroach upon the tubules in some places.

The arteries in the kidneys were normal in cases 5, 6, 7, and 9. In case 8 the slight arterial lesions were evidently purely incidental, which is probably also true in case 10; but in case 11 definite lesions were found in some of the arterioles and larger blood-vessels, which must be associated with the nephritis; and in case 12 the arterial involvement was unusually well marked. The lesions in these last cases seem to extend back from the affected glomeruli into the arterioles, and to consist in lateral hyaline thrombosis, with rapid organization leading to endarteritis. In the cellular newly-formed connective tissue in the intima there are practically no elastic fibers, as is well shown in fig. 18. In the larger arteries, on the other hand, there is no evidence of such a process; but there is present a definite hyperplastic thickening of the elastic tissue of the intima.

The arteriosclerosis found in other parts of the body in cases 8, 11 and 12 can almost certainly be looked upon as being unconnected with the renal disease. Cases 10, 11, and 12 demonstrate clearly that the blood pressure rises and remains constantly elevated before there are anatomical signs of general arterial disease. The rise in pressure must be due to some functional disturbance in arteries and heart, which throws out of action the regulatory mechanism which normally maintains the blood pressure at such a remarkably constant level.

The anaemia which was present in all cases is in all probability to be attributed to the chronic sepsis, rather than to the disease of the kidneys.

III. Late Subacute Glomerulo-Nephritis in Children (Cases 13-15)

The following three cases are of special interest because they show the effects of continued nephritis on the youthful organism. The patients were children between 6 and 10 years of age. The possibility of arteriosclerosis complicating the condition can be positively excluded in these cases, and as a matter of fact no general disease of the blood-vessels was observed in any of them. Whatever cardio-vascular disturbances were observed in these instances must therefore be in some way associated with the disease in the kidneys.

The first of these cases (13) had no history of any acute infections except the milder types of diseases of childhood. The possibility of her having had an attack of tonsillitis, rheumatism or scarlet fever was positively denied on repeated questioning, which is remarkable and shows that the diplostreptococci sometimes enter without provoking severe symptoms, because at necropsy it was discovered that she did suffer from an old diplostreptococcic infection of the aorta.

Her first symptoms, five months before death, were of a uraemic nature, of that type which gives rise to headaches, vomiting and convulsions. The convulsions in this patient were not very severe. They were frequently followed by periods of amaurosis, probably due to spasm in the retinal artery.

In addition to this functional and more or less transitory condition, organic lesions later developed in the fundus of her eyes; optic neuritis and retinitis, and a detachment of the retina in the left eye. After a while increased thirst and polyuria was noticed. She had remarkably little oedema of the skin (slight puffiness of the face at one time). Her polyuria with low specific gravity continued to the end. Otherwise the urinary changes were not very pronounced; the urine containing little albumin, few casts, and some leucocytes. Her systolic blood pressure was about 140. The clinical signs were pre-eminently those of a severe sepsis (continued fever and leucocytosis), and the general findings and also the local ones in the region of the heart again suggested strongly endocarditis, as in case 12. Contrary to all expectations, no endocardial lesion was discovered at autopsy, but an infectious aneurysm in the upper part of the abdominal aorta in which there were numerous diplostreptococci, and a severe glomerulo-nephritis with considerable shrinkage of one kidney.[2] The cardiac hypertrophy which had been noticed clinically

[2] The only clinical symptom of the aneurysm had been obscure pains in the upper abdominal region.

and had been ascribed to the suspected endocarditis, turned out to be due entirely to the "nephritic" hypertension. In this case the arteries were normal, grossly and microscopically, in kidneys and elsewhere, with the one exception of the arterioles in the spleen.

Patient 14, a girl of 10 years, had had frequent attacks of tonsillitis. She had a septic temperature on a subnormal base at about 96°F, also continually some leucocytosis; but the old septic focus, which evidently existed somewhere in her body, was not discovered at autopsy. The first symptoms, which appeared two years before death, were more of a cardiac nature (precordial pain and dyspnoea); and in her last attack the symptoms of broken compensation were the prevailing ones. Towards the end she was very restless and in a semi-comatose condition, probably as a result of true uraemia. Her blood pressure was quite high (160) for a child of her age, and the necropsy revealed marked hypertrophy of the heart, which was especially well developed on the left side. The urine contained much albumin and rather few casts, also a few erythrocytes occasionally.

The last one of these cases (15) showed a definite localization of the septic focus in the urinary tract. The involvement of the kidneys was not due to ascending infection, but it was in the nature of a true haematogenous glomerulo-nephritis (see fig. 27). Two years before this little boy's death a large stone was removed from his bladder. At that time already infection of his bladder was evident, and this infection with streptococci continued to his end. Cardiac and renal symptoms (polyuria) developed five months after the operation, and he died in uraemic coma. In this case also the cardiac hypertrophy was well marked, more especially on the left side.

In these three cases of late subacute nephritis in children, then, the cardio-vascular disturbances were very prominent clinically, and the cardiac hypertrophy well developed anatomically. Cases like these furnish the best proof that the hypertension is closely associated with the disease in the kidneys, but does not necessarily depend upon the extent of destruction of renal tissue. In case 15 the amount of functionating renal tissue left is very small; still the cardiac hypertrophy is quite insignificant in comparison with that observed in case 13, in which the damage to the kidneys is evidently much less extensive. In the growing body of a child the response of the heart muscle by hypertrophy to the increased work seems to be unusually rapid and extreme. That arterial spasm plays some rôle in the production of the hypertension is strongly suggested in case 13, in which the tendency to spasmodic contraction was so well marked in the retinal artery and was directly observed by means of the ophthal-

moscope. If, from the behavior of this one artery, one could arrive at a definite conclusion as to the state of the rest of the small arteries, the evidence would, of course, be more convincing; but unfortunately such is not the case.

Oedema was observed in two of these three cases, but it was not a prominent feature in any of them. Clinically a certain puffiness of the face was practically all that was noticed. In the last case, at autopsy all tissues were found to be unusually dry. In this connection it is interesting that the existence of a polyuria is especially emphasized in the records of cases 13 and 15. In case 14 it had been unfortunately impossible to determine the amount of urine. In cases 13 and 14, however, ascites and hydrothorax developed in the end.

In case 13 the urinary findings, apart from the polyuria, were unusually slight. Repeated examinations failed to reveal anything more than a small amount of albumin and occasionally a few hyaline casts. The albumin was much more plentiful in case 14, but here again the number of casts was limited. In case 15 the condition of the urine is unknown.

"Uraemic" symptoms were present in all three cases. The symptoms of the first patient started with headache and vomiting, and there were imperfectly developed convulsive attacks. Whether she eventually developed true uraemia and coma is unfortunately unknown. That this condition was present in case 14 is very probable from the history, and certain in case 15.

Whether the changes in the backgrounds of the eye which were observed in case 13 can be included in the usual picture of retinitis albuminurica is doubtful.

The anaemia which usually accompanies chronic sepsis and nephritis was present in all cases, but to a moderate degree only.

The kidneys, except for the one large kidney in case 13, were irregularly contracted. In cases 13 and 15 they showed large, deep, irregular scars; in case 14 they were more finely granular. The unusually small size of the one kidney in case 14 is probably partly due to disturbances arising from the stenosis of its ureter by a congenital fold.

The microscopical appearance of the lesions was very much that which has been described in the later cases of subacute nephritis in adults, only that in cases 14 and 15 in places the development of the fibrous tissue was more massive and the atrophy of the tubules in these areas further advanced, as is well shown in figures 25 and 28. The inflammatory character of the connective tissue proliferation was again very evident in all cases. Many glomeruli were already entirely fibrous, more especially in the older lesions.

original infection within the year, but usually ten years or more seem to elapse before they become at all prominent. The patients most commonly noticed them from two to five years before death; but in some, in which the disease, from the appearance of the kidneys, must have existed for many years, the complaints of the patients did not commence until four to five months before their end (see cases 28 and 29).

In practically all of our cases the history, when complete enough, contains quite definite evidence of renal disease, with the one exception of case 30, in which there is a fairly typical history of gout, but otherwise nothing suggestive of disease of the kidneys except the one complaint that he had to urinate frequently and had to get up several times at night. Curiously enough in this case the urinary findings also were very slight; both in spite of the fact that the lesions in the kidneys in the gross and histologically were unusually severe (see fig. 59).

There is another case (22) in which the only symptom for the last three years before death was occasional nycturia.[3] A rather common initial symptom was oedema, which in several cases commenced in the face, but not so rarely at the ankles. The time of onset of this initial symptom varied greatly.

In case 16 oedema of the face and legs developed three years before death, and since then recurred at intervals. Similarly in case 17 oedema and dyspnoea made their appearance two and one-half years before the end. Facial oedema was not observed until considerably later. In patient 20 the first symptoms manifested themselves four years before he died, and consisted of general oedema and ascites. In this case the oedema disappeared completely, to return slightly for a short time two months before death. All that was left eventually was some puffiness about the eyes. In case 22, as stated before, the only symptom for several years was occasional nycturia. It was only quite late in the disease that he developed marked oedema of the lower extremities, with very marked dyspnoea and cyanosis. Case 24 started in with dyspnoea and increasing weakness two years before his death. The dyspnoea again was a prominent feature in his last attack in which some facial oedema was observed; but there was no other oedema at any time. Patient 26 became dropsical as early as five years before his death, and had another similar attack four years later. In addition he complained of dyspnoea, palpitation of the heart, precordial pain, headache and pains in the legs. Patient 29 had noticed puffiness of the face, swollen legs, shortness of breath, palpitation of the heart, and precordial pain for about four to five months.

[3] The word "nycturia" in this paper is used as meaning urination at night, and is not meant to refer to involuntary urination.

IV. CHRONIC GLOMERULO-NEPHRITIS (Cases 16-32).

In order to avoid tedious repetition the cases of this last series will be taken up in a more summary fashion.

Ever since the disease has been recognized the etiology of these chronic cases has been a most vexing problem. Whereas in the acute and even the subacute cases the history of some septic infection can usually be obtained and a persisting septic focus can often be demonstrated fairly easily, in the chronic cases the history of the original infection dates back so far that it often is entirely forgotten by the patient, especially by patients who are more or less indifferent in regard to the state of their health; and the persisting focus apparently may be so insignificant that an unusually careful clinical examination and even an unusually carefully performed necropsy may fail to reveal it. In these cases the original infection is probably often due to organisms of a low degree of virulence which provoke very slight symptoms, and the bacteriaemia also is comparatively slight and intermittent, as one would expect from a comparatively insignificant and hidden focus.

In searching for the time and character of the original infection the question, how far one is able to communicate with the patient and his family, is of great importance; so that in patients able to speak foreign languages only, especially such languages as Chinese and Japanese, it is often a practically hopeless task. Many of these patients arrive at the hospital in a comatose condition, and, unless close relatives or friends are accessible, very little or nothing can be made out about their antecedents.

Among our sixteen cases there were seven (cases 16, 18, 20, 25, 27, 29, 32) in which for one reason or another the history is imperfect. Of the other nine patients one (17) had scarlet fever as a child and rheumatism at twenty years of age, another (19) claimed to have been healthy all his life. He even denied having had any diseases in childhood, which makes his statements somewhat improbable. Patient 21 had had a severe infection, "a touch of typhoid," as she said, at the age of 22, and her symptoms dated from the time she was 23. Patient 22 had had a long continued suppuration of the neck due to chronic tuberculosis, necessitating twelve operations. In such a case the existence and persistence of mixed infection with septic organisms is, of course, not at all unlikely. In the history of patient 23 we read of repeated attacks of tonsillitis and several attacks of polyarticular rheumatism. Patient 24 also has a history of rheumatism. In case 26 we encounter once more a

general denial of all diseases except measles in infancy. In case 28 also there is no statement in regard to the original infection. Patient 30 had had frequent attacks of sore throat, and patient 31 had had what she called "La Grippe" as a girl and an attack of acute appendicitis nine years before her death. A direct relation of the original infection to the following nephritis is traceable only in one case (21); still the investigation shows that in fully six of the nine cases the existence of some infection preceding the nephritis and likely to provoke nephritis, could be established.

The mere presence of such a history does not of course prove that the nephritis must have been due to such infection. However, in this connection we have to consider that in all acute and subacute cases the relation of such infections to the nephritis is very evident; and there is no reason to assume that the chronic cases of evidently the same disease should be due to a different cause. Considering the difficulties, I believe that the finding of a history of a suspicious infection in six out of nine complete histories is quite suggestive—all the more so, as in one of these negative cases (28) in spite of the denial of all infection and in the absence of any symptoms observed by the patient, a chronic infectious endocarditis was found at autopsy.

Definitely persisting septic foci were found in the sixteen cases as follows: old atheromatous ulcers infected with diplococci in case 16; old pus pockets in the tonsils with considerable scarring in case 20; an old healed scar at the base of the aorta and an old septic infarct of the spleen full of influenza bacilli in the patient (21) who had had a "touch of typhoid" thirteen years before her death; an old ulcerative endocarditis in the patient (23) who had a history of tonsillitis and rheumatism; an old ulcerative endocarditis in case 28; an old ulcerative tonsillitis and an apparently old mild suppurative pyelitis in the patient (31) who had had the attack of "La Grippe." The long continuance of the rheumatic infection in case 17 is shown by the fact that many years after his original trouble he developed a pleurisy, evidently on a rheumatic basis, because there was no evidence of tuberculosis found at autopsy. It is also to be noted that during the last years of his life he complained for several years of chills in the evening and night sweats. In case 32 there is a history of "malaria," so frequently wrongly diagnosed in chronic sepsis; and in case 30, with a history of tonsillitis, there is a subsequent history of repeated attacks of arthritis, which may, however, have been gouty in character.

Altogether of the sixteen cases there are six only which are entirely negative so far as history and autopsy findings are concerned; and of

these, four have imperfect histories. One of these (19) had a chronic suppurative catarrh of the rectum due to diplostreptococcus infection, and a diplostreptococcus sepsis at autopsy. There was no way of determining the age of this infection, because the infection of the rectum had not been noticed by the patient, but was accidentally discovered when a routine examination of the rectum was made after he had entered the hospital.

No really careful examination of the nose, the accessory sinuses, the roots of the teeth, and other well known foci of chronic septic infection, was made in these cases either clinically or anatomically; and I believe the result should encourage us to search more carefully for such conditions. Even under the most favorable circumstances we can hardly hope, in a disease which often lasts twenty years and more, to definitely establish its relation to chronic sepsis in more than a majority of cases. My impression is, that the original infection usually takes place at a comparatively early age (fifteen to twenty years and longer before death), and, as is clearly shown in several of the histories, is unfortunately not immediately followed by clear symptoms of nephritis, the earliest symptoms (possibly indicating renal disease and consisting of headache and vomiting) having been observed about one year after the infection in case 21. Otherwise the damage to the kidneys is not noticed at the time, nor the persistence of the infection in some more or less hidden focus. Whether a careful clinical examination at the time, with urinanalysis, etc., would reveal the seriousness of the condition remains to be seen, but does not seem at all unlikely.

In such an early discovery of the real seriousness of the situation would consist the only hope of the patient for a permanent cure, by the possible eradication of the septic focus, a general treatment directed towards increased resistance to infection, and a careful symptomatic treatment of the disease of the kidneys. My belief is, that the acute nephritis in scarlet fever is so rarely followed by chronic nephritis, because in the first place the septic infection in scarlet fever is self-limited, and if the patients recover, heals completely; and secondly, because the patients usually are in bed under professional care and the nephritis often is severe enough to be noticed easily, both of these latter circumstances assuring proper treatment. In the more obscure septic infections neither the original disease nor the nephritis which is associated with it may attract sufficient attention on the part of the patient, or of the physician if the case happens to be brought to the attention of a professional man.

The time at which the first definite "renal" symptoms make their appearance varies very much. In case 21 they seem to have followed the

original infection within the year, but usually ten years or more seem to elapse before they become at all prominent. The patients most commonly noticed them from two to five years before death; but in some, in which the disease, from the appearance of the kidneys, must have existed for many years, the complaints of the patients did not commence until four to five months before their end (see cases 28 and 29).

In practically all of our cases the history, when complete enough, contains quite definite evidence of renal disease, with the one exception of case 30, in which there is a fairly typical history of gout, but otherwise nothing suggestive of disease of the kidneys except the one complaint that he had to urinate frequently and had to get up several times at night. Curiously enough in this case the urinary findings also were very slight; both in spite of the fact that the lesions in the kidneys in the gross and histologically were unusually severe (see fig. 59).

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There is no history of a previous attack, but the data are incomplete. In case 31 the exact nature of the renal symptoms which were first observed when she was pregnant five years before death is not stated; but in her subsequent history oedema is not a very prominent symptom.

In six cases, then, oedema was an early and prominent symptom.

Dyspnoea, as may be seen from the above, was often noticed very early, and this symptom frequently was very severe, out of all proportion to any disturbance in circulation that might have been present. In case 28 it was an early and apparently the most prominent clinical symptom, not associated with oedema or any more definite "uraemic" manifestation. It is not at all improbable that the attacks of "asthma" in case 19 which preceded the end by four years were of this nature. In this patient it was years later that oedema first developed, and he died, similarly to case 28, in extreme dyspnoea.

Palpitations of the heart were quite frequently complained of, and in a few instances there was quite a little precordial distress, sometimes suggesting angina pectoris. The patient in whom this symptom was most prominent (17) had an unusually well marked general arteriosclerosis. The right coronary artery was almost closed at one point, but there were no scars in the heart muscle. In case 26, with similar symptoms, the necropsy also revealed marked arteriosclerosis of the coronary arteries. In cases 21 and 29, however, in which anginoid attacks were complained of, there were no lesions in the coronary arteries or in the heart muscle, and merely a few small yellow spots in the base of the aorta. On the other hand, in case 18, in which there were small scars in the musculature of the left ventricle, no local symptoms were complained of. Patient 24, in whom the heart muscle was similarly affected, also did not complain of any subjective symptoms in the region of the heart, but clinical examination revealed an absolute arythmia. (It may be stated that the heart muscle, like all other important organs, was examined microscopically in all cases.)

In a certain number of cases "uraemic" symptoms occurred early and often dominated the clinical picture. In the early stages the convulsive form of uraemia, characterized by headache, vomiting, and, in extreme cases, convulsions, was usually encountered. Towards the end the symptoms of true uraemia made their appearance, often terminating in coma.[4] In case 17, for instance, the first symptoms two years before death were headache, dizziness, loss of memory, failing eyesight, shortness of breath, progressive weakness, and frequent urination. This man

[4] A discussion of the different forms of uraemia cannot here be attempted, and the reader is referred to the voluminous literature on this subject.

never had any oedema, except slight puffiness of the eyelids. He had a retinitis albuminurica, uraemic convulsions, and died in coma. The symptoms of patient 21 started thirteen years before her death with intense headache and vomiting. She had much oedema at times, and eventually developed symptoms of true uraemia. In case 23 the uraemic convulsions were evidently mistaken for epilepsy. When he came to the hospital, he complained of shortness of breath, increasing dimness of vision, cramps in the legs, and deep pains in the bones. He never had any oedema, and died in uraemic coma.

In other cases again the uraemic symptoms were a late development, as in patient 20, who first had considerable oedema. Later the oedema was much less marked, but he had intense headaches with vomiting, became severely dyspnoeic, was intensely hypersensitive all over his body, especially to deep pressure, and died in an attack of excessive dyspnoea. The patient (22) in whom frequent urination, especially at night, was the only symptom for several years, eventually developed an intense dyspnoea, had some oedema, and died in uraemic coma. In patient 31 the exact symptoms of her earlier attacks are unfortunately unknown. One year before death she noticed anorexia and vomiting. Later she had some attacks of violent delirium, associated with complete unconsciousness. For the last seven months she had headache, much vomiting, jerkings and cramps in legs, progressive amaurosis, and at times oedema of the feet. Ophthalmological examination showed the typical picture of an albuminuric retinitis. The symptoms of true uraemia continued to her death.

Retinitis albuminurica was observed in the above mentioned two cases only. In case 23, in spite of the failing vision, the backgrounds were normal. The retinal arteries were slightly tortuous, and the disturbance may have been due to this patient's severe anaemia, associated with arterial spasm.

All patients, with few exceptions, suffered from severe anaemia. About half the normal number of erythrocytes, or less, and a corresponding decrease in haemoglobin, was observed in cases 17, 19, 20, 23, 24, 28, 29, 30, 31. In several of these cases there was a marked anisocytosis. Associated with the anaemia there was frequently observed a tendency to bleeding in skin and mucous membranes, assuming at times the severity of a haemorrhagic diathesis.

The temperature was either normal or often subnormal, with occasional rises to 99° or 99.5° F. The pulse rate was either normal, or as in case 29 rather slow (between 60 and 80), but in quite a number of cases it varied considerably, and occasionally rose to 100 or even 120.

These disturbances in pulse and temperature are probably due to the associated septic conditions. It is of some interest that in case 21, in which an old septic infarct heavily infected with influenza bacilli was found in the spleen, the temperature was normal, but the pulse rate varied a great deal and sometimes rose to 120.

In practically all, but more especially in the uraemic cases, the tongue in the last stages of the disease was heavily coated and the breath was foul. In some of them a severe pseudomembranous and ulcerative stomatitis developed eventually, which in case 16 was mistaken for diphtheria, because it started in the region of the tonsils and gave rise to the formation of greyish membranes. The lesions usually, however, are much more widely distributed than those of diphtheria, involving gums, palate, inner surface of cheeks, lower surface of tongue and floor of mouth, etc. The base of these superficial ulcerations is either exposed and then greyish white, due to the necrosis of the tissues; or it is covered with thick brownish crusts. The condition is so characteristic that one might speak of it as a "stomatitis uraemica." These lesions are usually directly due to streptococcus infection of the weakened tissues.

In the majority of the chronic cases the systolic blood pressure was distinctly elevated, varying from 160 to 250. Elevations to 200 and more were present in five cases (17, 18, 22, 23, 26). As the cases are arranged somewhat according to the severity of the lesions in the kidneys, it is evident from the figures that the amount of destruction of kidney tissue in itself does not control this phenomenon. In fact, there are more cases with low pressures and small hearts among the cases with the most extensive destruction of renal tissue than among those with less destruction. The patients with unusually high pressures were all rather strongly built males between 45 and 55. Three of them had a marked general arteriosclerosis, one had fairly normal, and the last one entirely normal arteries. On the other hand some of the cases with the most marked and extensive general arteriosclerosis had low pressures and small hearts. One gets the impression, therefore, that the pressure is forced up more energetically in comparatively vigorous individuals, when the disease develops comparatively rapidly and leads to death before extreme changes have taken place in the kidneys.

The cardiac hypertrophy is evidently caused by the hypertension, but it is by no means proportionate to it. The largest heart (24) was found in an individual with a blood pressure of 170, which on rest in bed came down to 135. On the whole, the hypertrophy of the heart remains within moderate limits, varying from one and one-fourth to one and one-half times normal size in bulk. The hypertrophy is primarily a concentric

hypertrophy of the left ventricle (see for instance cases 16 and 19), followed by its dilatation and later sometimes by involvement of the right heart; but the cases showing much dilatation on the right side and marked cyanotic atrophy of the liver, as a sign of chronic passive congestion in the peripheral veins, are quite small in number (see cases 19, 26, 27).

Cases with low pressures and normal, or even small, hearts are by no means rare, especially in very chronic cases with extreme contraction of the kidneys (see cases 25, 28, 29 and 32).

The relation of chronic nephritis to gout is again brought out prominently by our series of cases. Only one of them (30) had a definite clinical history of gouty arthritis, but gouty lesions in kidneys and elsewhere were encountered in five cases (24, 26, 27, 29, 30), without a systematic search in every instance. It is reasonable to assume, therefore, that actually the incidence was greater than is indicated in our records. It appears especially to occur in the very chronic cases with extreme kidney lesions (second half of this series). The recent observations of Denis [5] that in healthy individuals an excess of purins is rapidly excreted, leaving the uric acid percentage in the blood undisturbed, whereas retention follows early in cases with renal insufficiency, may furnish some clue to the frequency of this association.

The death of the patients was either the result of terminal infection, usually broncho-pneumonia (cases 16, 23, 24, 25, 27, 28, 29, 30), or of true uraemia (17, 18, 19, 20, 21, 22, 26, 27, 28, 31). In the latter case the patients often developed uraemic coma, but some showed no disturbance of consciousness, merely excessive dyspnoea (19, 20, 28).

As may be seen from the table of summary of the cases, the urinary findings were fairly constant in all cases. Polyuria was a very prominent symptom, occurring at one time or another in seven out of the thirteen cases in which anything definite is known of the urine. This was commonly associated with frequent urination at night (nycturia). The amount of urine was definitely increased in about one-half of the cases. In three the quantity is designated as decreased. The specific gravity was generally low (1010 and less). The lowest specific gravity (1002) was found in the most acute case (16) of this series. The specific gravity was low, not only in the cases with polyuria, but also in some of those with a decreased amount of urine, suggesting hyposthenuria (Schlayer). (See cases 22, 23 and 24.)

With few exceptions (19, 29, 30), the urine contained much albumin

[5] Denis, "The Effect of ingested Purins on the Uric Acid Content of the Blood." *Jour. of Biol. Chem.*, 1915, XXIII, 147.

(at least a heavy cloud). The albuminuria was moderate in cases 19 and 29. In case 30 no albumin was found, but the patient was at the hospital for a short time and there is record of one examination only.

The finding of casts was not so constant. There were several cases in which no casts were found, but repeated examination usually revealed showers of casts once in a while. Frequent examinations of the urinary sediment are therefore of great importance. Leucocytes and erythrocytes were discovered only occasionally. The difficulty of finding formed elements in the urine at times is rather astonishing, because in sections of these kidneys casts are always fairly numerous, and frequently quite a few tubules are filled with blood or leucocytes (see protocols of individual cases). It may be that in these later stages the contents of the tubules are washed out less easily and are carried down only when there is a more or less sudden flood of urine.

The phenolsulphone-phthalein test was employed in a few cases only, many of them dating back before its introduction. In every instance the excretion was distinctly slowed. In case 26 there was no excretion in three trials.

The gross appearances of the kidneys varied considerably, except that they all showed evidences of contraction. The capsule was more or less thickened and adherent. The surface of the kidneys was either smooth or granular, or full of large irregular scars, more or less lobulated, according to the distribution of the newly formed connective tissue.[6] The color was frequently mottled, purple and grey, or in other cases dark red, in others again quite pale. In quite a few cases one could make out small petechial haemorrhages. The number of them varied from a few to a great many. In some instances the color of the organ was distinctly brown on account of an abundant deposit of haematogenous pigment in the epithelium. On the cut surface the cortex naturally appeared more or less contracted, and on account of the great structural alterations the normal markings of the cortex had disappeared to a great extent. If there was much epithelial degeneration, opaque, frequent yellowish spots were seen scattered through the cortex. The arteries on the cut surface varied greatly. In some cases they were distinctly thickened, in others they were entirely normal. The same is true of the main stems of the renal arteries.

Histologically the connecting link of all cases was the inflammatory lesions in the glomeruli and the inflammatory proliferation and eventual fibrosis of the connective tissue. The great variety of lesions encountered

[6] The differences are well shown in the photographs accompanying the individual cases. They are all taken at nearly one-half normal size.

is well illustrated in the photomicrographs. Still they all show the same pattern. The inflammatory character of these lesions is naturally most evident in the more acute cases, but even in the very old cases typical subacute lesions may be encountered in some of the glomeruli (see photomicrograph of case 31) and in certain parts of the interstitial tissue. Eventually most of the glomeruli become shrunken and fibrous. The newly formed connective tissue also becomes more and more fibrous and the neutrophilic leucocytes disappear from it, but eosinophiles and "Mastzellen" persist for a long time.

The extent of the epithelial degeneration varied very much. In some cases granular and fatty degeneration was very well marked, in others there was hardly any evidence of it. I cannot say that it appeared as if the cases with much epithelial degeneration were more likely to develop oedema, as has been suggested. It is to be considered that the relation of the oedema to the epithelial degeneration may be the opposite from that which is usually assumed. If there is general oedema at the time of death involving the kidneys, the existence of this oedema in the kidneys may very well favor the development of degenerative changes in the epithelium.

Eventually the majority of the tubules collapse, and the amount of tissue destruction may continue to an astonishing degree before death ensues. In those cases in which the glomerular involvement and the connective tissue development are of a patchy character the remaining comparatively normal glomeruli and tubules often show evidences of compensatory hypertrophy. These latter conditions, however, do not seem to have much effect on the clinical picture. The development of numerous small cysts is quite common in the later stages.

Bacteria were found in the tissues in one early case only (case 16). It was the most acute case of this series, a case in which there existed an infection of old atheromatous ulcers with diplostreptococci. The diplostreptococci were found in many capillaries, and a few outside in the inflamed connective tissue. Once more, no bacteria were discovered in the diseased glomeruli.

This same case had acute and very marked lesions in the arterioles, consisting of hyaline thrombosis which in some places filled the arterioles completely, in others formed a thick layer on the inner surface partly above, partly below the endothelium. In other small arteries these hyaline masses had been partly or completely organized, giving rise eventually to the picture of a cellular endarteritis. In what appeared as the later stages of the same process much elastic tissue had developed in the thickened intima, in such a way that eventually an appearance was pro-

duced resembling that described by Jores as characteristic of the "functional" hyperplasia of the intima in arteriosclerosis.

In case 18 the thrombotic obstruction of some of the arterioles had given rise to the formation of many microscopic anaemic necroses. Both the small and the larger arteries showed a very marked thickening of the intima, partly with hyperplastic development of the elastic tissue, partly without. Similarly the two processes were mixed in case 17. In case 20 the arterial changes seem to be old, both in arterioles and in the larger arteries, and we find much elastic tissue in both places. In case 22 some small arteries show "endarteritis," others "arteriosclerosis." In this and many other specimens (see individual records) one finds all transitional stages between these two conditions.

In a general way one may state that the arterioles in the kidney are affected in all cases, but that even in the oldest and most severe cases, like cases 31 and 32, the larger arteries in the kidneys and elsewhere may show very little evidence of disease.

It appears therefore ill advised to indulge in too much speculation in regard to the etiology of the process in the arteries from the histological appearance of the lesions, and I believe that until further proof to the contrary is forthcoming we are justified in assuming that the changes in the arteries in these diseased kidneys are of an inflammatory nature, just as the rest of the lesions. This interpretation would harmonize very well with the observation that in the small arteries at least the proliferation of the intima is frequently preceded by lateral thrombosis, bearing in mind the fact that inflammation of the arterial wall necessarily would favor thrombosis.

In conclusion I may be permitted to add a few general statements. It may seem as if this were hardly warranted on account of the small number of cases studied; and there certainly would be justification for criticism, if an attempt were made to elaborate a complete pathology and symptomatology of chronic nephritis on such a slender basis. On this account all preceding statements have been worded so as to refer to the individual cases only. But, on the other hand, a few thoroughly studied cases may give some food for general reflection.

If these cases teach anything, they certainly bring out very clearly the loose association which exists between the condition in the kidneys and a number of other phenomena which have usually been rather loosely described as "nephritic." Terms like "nephritic" oedema or "nephritic" hypertension cannot fail to give the impression that the oedema or the

hypertension depend directly on the condition of the kidneys. To my mind nothing could be further from the truth. These conditions are frequently associated with nephritis, but the kidneys themselves play no demonstrable rôle in their origin.

This will be perhaps more easily conceded in case of the oedema. All attempts at explaining the oedema on the basis of the disease in the kidneys have failed, and as a matter of fact a cursory study of these thirty-two cases will show that there is no one element in the pathology of the kidneys with which the oedema could be connected. Practically the same lesions may be observed in the kidneys of patients which were "water-logged" long and often, and in patients who had oedema rarely or not at all. One may object that the anatomical picture of the kidney does not give a true representation of its functional capacity, and that functional tests show that certain *functional* derangements of the kidney are apt to be associated with oedema. I very much hesitate to express an opinion on this latter point on account of lack of experience and knowledge; but this much is certain, that in these functional studies it is often difficult to determine what is cause and effect; and there is certainly no unanimity of opinion among those most competent to judge in questions of this character. But apart from all such controversies, how much easier of solution does the whole question become if we give up this idea and state the relation somewhat in the following manner: The agency which produces the nephritis (certain bacterial toxins), in addition to injuring the capillaries in the kidneys also injures them elsewhere, and this produces the oedema.

We need only to think of the word "inflammation" to realize that this is possible, because the most striking effect of bacterial toxins in the tissues is injury to the capillaries. Of diffuse injury to the renal capillaries (besides the characteristic lesions in the glomeruli), we have ample evidence in the acute and subacute cases of the disease. The oedematous swelling of the kidneys is often extreme, and the extent and importance of this oedema seems to have hardly sufficiently impressed itself upon anatomists and clinicians. If this is the true relation of things, we can understand much more easily why the relation of the nephritis to the oedema should be so varying. In a certain case the kidneys may be damaged very severely, but the capillaries in it or elsewhere much less so; and vice versa. Given damaged capillaries, the factors which damage them additionally or which in other ways favor the development of oedema may naturally provoke to manifestation a condition which may be more or less latent, or aggravate an oedema that is already plainly in existence. The damage being general, the

capillaries in the delicate structure of the eye-lids may show the damage first; whereas in other cases the oedema may first show in places where the circulation is relatively poor, as in the region of the ankles.

It appears to me that an assumption like the one made above clears away innumerable difficulties, and at the same time permits the utilization of all the important data which have gradually accumulated as a result of patient clinical investigation. I should suggest, therefore, that the term "nephritic oedema" should be replaced by "oedema in nephritis."

The same way with "nephritic" hypertension. Here also the looseness of the interrelation of this phenomenon to the disease of the kidneys is so evident that it does not need special emphasis; in fact, this lack of correlation has been the despair of all those who have attempted its explanation scientifically. It appears a little more hazardous to ascribe these differences also to differences in the action of the causative agent which provokes the nephritis. It is not known of bacterial toxins that they affect the tonus of the arterioles, and yet, whatever causes the hypertension must affect them. The condition of the large arteries is immaterial. An increased activity of the heart would be easily compensated for by the vasomotor regulatory mechanism; but when the tonus of the arterioles is increased the vasomotor regulation breaks down, as we know in the case of adrenalin and pituitrin hypertension, probably because the mechanism works by means of the arterioles and has little reflex control over the heart action. If it could be shown that substances produced by bacteria directly or indirectly had a pressor action, then all difficulties would disappear, as in the similar case of the oedema. Then one would be able to understand why we should have sometimes early and extreme hypertension, at other times none at all. If we make the further assumption that these or similar substances *sometimes* do not only stimulate the arterial wall to contraction, but also injure it, we would come much nearer to the solution of the "arteriosclerosis" problem; in fact it might lead us to an entirely new conception of the etiology of arteriosclerosis and its puzzling relation to hypertension and nephritis, because after all is said and done arteriosclerosis and arteriosclerotic hypertension have some intimate relation to nephritis, but certainly not the one usually thought of, namely, that the nephritis is the primary factor. An assumption like the one mentioned above is naturally still altogether speculative, and it will take much work to get close enough to these important problems to make positive statements; but, whatever the relation is, I believe it may be positively asserted that nephritis and hypertension are not related to one another as cause and effect.

Clinicians have already recognized that certain forms of uraemia

are not due to the injury to kidney tissue, but to other factors. The convulsive form of uraemia is, for instance, almost certainly due to disturbances in the cranial cavity, the exact nature of which is still far from being recognized; and similarly it may be with other forms of this protean symptom-complex. The only condition in which we have good reason to believe that it is directly the consequence of destruction of kidney tissue is what clinicians now usually speak of as "true" uraemia; and in this condition the evidence that it is due to an inefficiency on the part of the kidneys to excrete some as yet unknown substance or substances has been accumulating rapidly in the last years.

In regard to the changes in the *composition* of the urine and its sediment I wish to emphasize once more, as has been done often enough before, that the condition of the urine is a fairly accurate measure of the severity of the disease in the kidneys at a given time, and no measure at all of the extent of the damage to the renal tissue. Polyuria and hyposthenuria more particularly point to serious involvement of much kidney tissue, although of course other possible factors have to be taken into account. The records also bring out clearly that frequent careful urinanalyses are of great importance in the clinical recognition of the disease.

It is impossible to condense the result of these observations into a few phrases, but our main conclusions might be formulated as follows:

1. Diffuse glomerulo-nephritis is a disease which may occur in acute, subacute, or chronic form.

2. The etiology of the acute and subacute forms is evidently to be found in bacterial infection, and this is quite probably true of the chronic form.

3. The bacteria concerned are commonly, but not necessarily, members of the streptococcus family.

4. It is probable that the continuance of the disease in the kidneys is due to the continuance of the infection in some often more or less hidden focus.

5. It is suggested that one should look upon the oedema, the hypertension, the arteriosclerosis, and certain uraemic manifestations merely as being frequently associated with nephritis, rather than as being directly dependent upon it.

6. It is quite conceivable that these manifestations are the result of the fortuitous action upon other tissues of the same cause which injures the kidneys.

RECORD OF CASES

Case 1. Old focal and acute diffuse glomerulo-nephritis in man of 52 years, with chronic diplostreptococcic endocarditis.

XVII, 60.— J. K., strongly built, emaciated American engineer, 52 years old.

The patient had had occasional attacks of sore throat. His first definite symptoms were observed eight years before death, when he developed palpitations with dyspnoea. A similar attack with chills and fever was observed three years later. Eight months before death he had oedema of the legs. His last attack began four months before his death with abdominal cramps, diarrhoea, dyspnoea, and expectoration. During this last attack he ran an irregular septic temperature. Clinically he showed evidences of aortic regurgitation. There was marked oedema of the legs and later of the trunk, and symptoms of hydrothorax. Towards the end oedema and hydrothorax disappeared. He had a slight anaemia (4,000,000 reds; Hb. 60%), no leucocytosis (3-10,000). He had a positive Wassermann reaction, although he denied lues and nothing suggestive of syphilis was found at autopsy. Two blood cultures were negative. Diplostreptococci were found in the urine. The urine showed a heavy cloud of albumin, many hyaline and granular casts. It was first decreased in amount, later increased with the disappearance of the oedema. The phenolsulphone-phthalein secretion was slowed (35% 1st hour, 15% the 2d).

Necropsy revealed an old, aortic diplostreptococcic endocarditis with regurgitation, and a large spleen with numerous large areas of haemorrhagic softening which were full of streptococci. There was a slight general arteriosclerosis.

The kidneys were slightly swollen (12 x 6 x 3 cm.) and smooth. The cortex was fairly wide, opaque, and showed a moderate number of haemorrhagic spots. There was a small anaemic infarction in the right kidney.

Sections showed few fibrous glomeruli with areas of cellular infiltration and moderate thickening of the connective tissue about them; few neutrophilic and eosinophilic leucocytes in these areas of cellular infiltration; infiltration of most glomeruli with neutrophilic leucocytes; recent hyaline necrosis of loops in a fair number; no extra-capillary

Fig. 1.

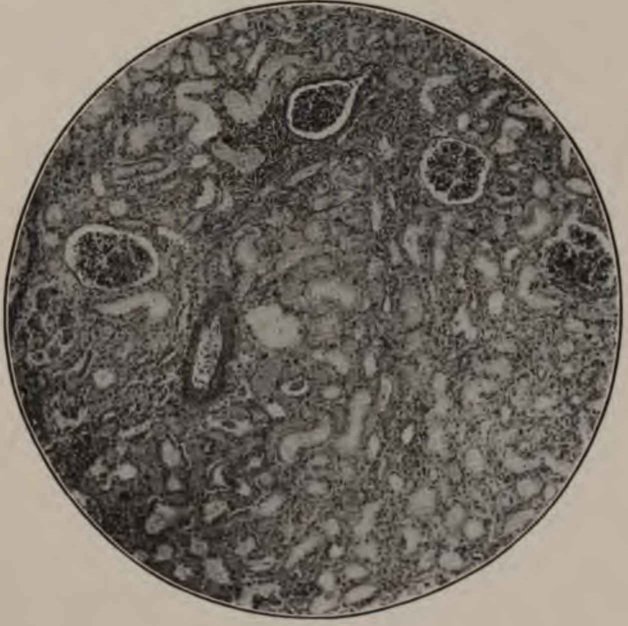

Fig. 2.

proliferation; very marked hyperaemia; few haemorrhages; few casts; little epithelial degeneration; beginning "arteriosclerosis" of some small arteries. Many small vessels were filled with coccus-emboli. The tissue about some of these was necrotic and showed beginning suppuration. No cocci were found in any of the diseased glomeruli.

Case 2. Old focal and acute diffuse glomerulo-nephritis in man of 54 years, following recrudescence of chronic diplostreptococcic endocarditis.

XVII, 31.—J. N., American kitchen-helper, 54 years of age.

Patient had an attack of acute polyarticular rheumatism followed by sharp precordial pain radiating into arms twenty years before death. Since then he had had three to four attacks a year. He was always

Fig. 3.

short of breath, and had palpitations of the heart. He was nervous and slept poorly. At times he had severe headaches, dizziness and night sweats. Lately he complained of renewed pain over the heart, shortness of breath, and oedema at the ankles which he observed for the first time. Clinically he presented evidences of aortic stenosis and regurgitation.

His blood pressure was 170 on entrance, but later went down to 140-150. He had a slight anaemia (4,000,000 reds; Hb. 85%) and a slight leucocytosis (10,000). He had a positive Wassermann reaction, although he denied lues; nothing suggestive of syphilis was found at autopsy. His temperature was at times subnormal, and his pulse rate varied between 80 and 100. His urine showed a light cloud of albumin and few granular casts.

Necropsy revealed an old aortic diplostreptococcic endocarditis with recent exacerbation, moderate general arteriosclerosis.

The kidneys were of about normal size and full of minute haemorrhages.

Sections showed few glomeruli with old glomerulo-nephritis and small areas of cellular infiltration and connective tissue proliferation in the vicinity; infiltration with neutrophilic leucocytes in majority of glomeruli; necrotic loops in few of them; extra-capillary proliferation about some of these tufts; many haemorrhages, few leucocytes, few casts in tubules; marked leucocytosis in capillaries and few neutrophilic leucocytes in the interstitial tissue; marked fatty degeneration and beginning necrosis of the epithelium; beginning "arteriosclerosis" in some small arteries. No pathogenic bacteria were found in the sections.

Case 3. Old focal and acute diffuse glomerulo-nephritis in a man of 41 years, with old diplostreptococcic endocarditis.

XVII, 188.— M. E., fairly strongly built, fairly well nourished Spanish farmhand and teamster, 41 years of age.

History imperfect on account of condition of patient, who died one day after entrance. He claimed to have been well until a sudden breakdown three weeks before, while at work in the fields. Since then he became weaker, dyspnoeic and oedematous. At first he had frequent urination of small amounts of urine; later he had to urinate less frequently, and the oedematous swelling increased correspondingly. A few days before death he began to have bloody expectoration. Clinical examination showed extreme dyspnoea, much cough with bloody expectoration, a heart of apparently normal size, a blowing systolic murmur, much oedema. He had a high pulse rate (103) and a moderate temperature 101° F). His blood-pressure was 140. His urine had a specific gravity of 1012, contained much albumin, many hyaline and granular casts, and few leucocytes.

Necropsy revealed an old aortic diplostreptoccic endocarditis with some stenosis, a heart about one and one-fourth times normal size, cyan-

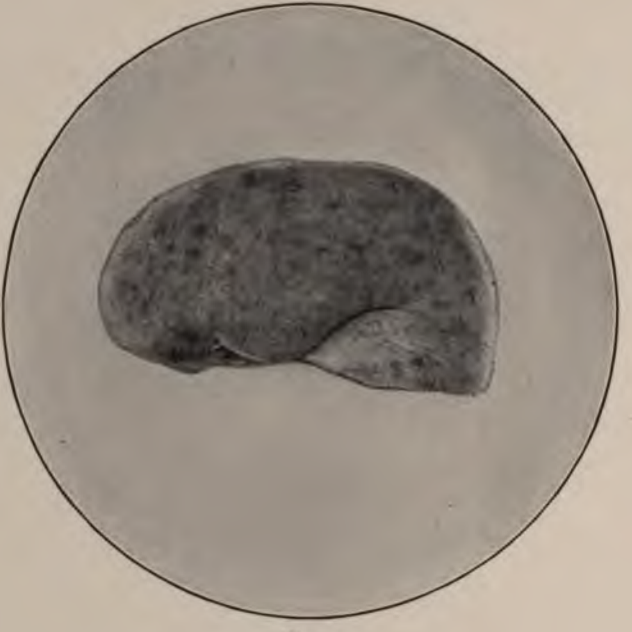

Fig. 4.

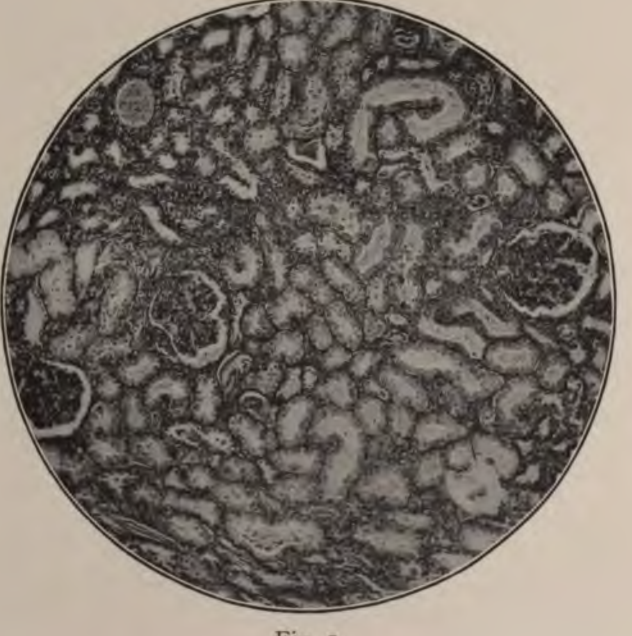

Fig. 5.

otic atrophy of liver, much oedema, ascites and hydrothorax, also an acute glaucoma of the left eye. The arteries were practically normal.

The kidneys were swollen (13 x 7 x 4½ cm.) and smooth. The cortex was wide, yellow, opaque, and full of minute haemorrhages. There was an old infarct in the left kidney.

Sections showed old glomerulo-nephritis in few glomeruli, which were surrounded by small areas of cellular infiltration, and fibrous thickening of the connective tissue. The majority of the glomeruli were infiltrated with neutrophilic leucocytes; hyaline necroses were found in several, and beginning extra-capillary proliferation in some. Some tubules were filled with blood; many also contained leucocytes. The interstitial tissue was moderately infiltrated with neutrophiles. There was little degeneration in the epithelium; beginning "arteriosclerosis" in few small arteries. The sections were too badly contaminated to permit of bacteriological examination.

Case 4. Acute glomerulo-nephritis in woman of 33 years, with cirrhosis and large septic phagedenic ulcers of leg.

XVIII, 158.— Mrs. A. B., delicately built, fairly well nourished Italian housewife, 33 years of age.

Patient came to clinic two years before death, complaining of swelling of abdomen and feet. Five years before death she had her first attack of swelling of the abdomen with jaundice. About three months before death ulcers developed on the right leg, which became progressively worse. One month before death the symptoms of cirrhosis became more aggravated. Clinical examination showed the usual symptoms of cirrhosis, large phagedenic ulcers on right leg. Treatment with salvarsan made the ulcers on the legs much worse. Her temperature was high and somewhat irregular; her pulse accelerated and irregular. Towards the end she became irrational, and some oedema appeared on her face. The Wassermann reaction, which had been negative before, became positive at this time. She was quite anaemic (Hb. 63%). The urine contained much albumin, at times many granular and cellular casts, and very many leucocytes.

Necropsy revealed extensive old cirrhosis and several large phagedenic ulcers on right leg. Smears from the most acute one of these ulcers showed many streptococci. Streptococci were also found in a thrombus in the right auricle and in the spleen. The heart was slightly dilated on the right side. The large blood-vessels were normal.

The capsule of the kidneys stripped easily. The surface was very slightly granular. They were extremely hyperaemic and oedematous, and very distinctly swollen ($12\frac{1}{2} \times 6 \times 4\frac{1}{2}$ cm.). On the cut surface the cortex was wide, and showed a certain number of small opaque spots. No haemorrhages were seen in the gross specimen.

Microscopic sections showed a diffuse intra-capillary, and in places extra-capillary, glomerulo-nephritis. The glomeruli were heavily in-

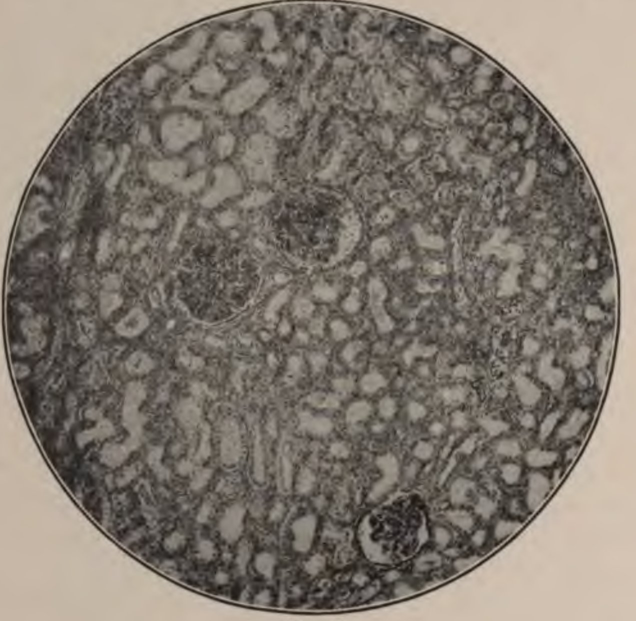

Fig. 6.

filtrated with polymorphonuclear leucocytes. Many of them showed hyaline necrosis of some of the loops. In few glomeruli the changes were advanced to the subacute stage. Many tubules were filled with blood and leucocytes. The epithelium showed some granular and a little fatty degeneration. The interstitial tissue was hyperaemic, oedematous, and slightly proliferated. There was a moderate infiltration, with granular leucocytes and lymphocytes. No bacteria were found in sections. The small arteries were normal, the larger ones were slightly "arteriosclerotic."

Case 5. Early subacute glomerulo-nephritis in a woman of 33 years with subacute diplostreptococcic endocarditis.

XVIII, 166.— Mrs. R. B., strongly built, poorly nourished Italian housewife, 33 years of age.

Patient was admitted to hospital ten days before her death, complaining of vomiting, shortness of breath, and swelling of feet. Nine months before, she had an attack of acute polyarticular rheumatism, ushered in by tonsillitis. The pains in the joints continued intermit-

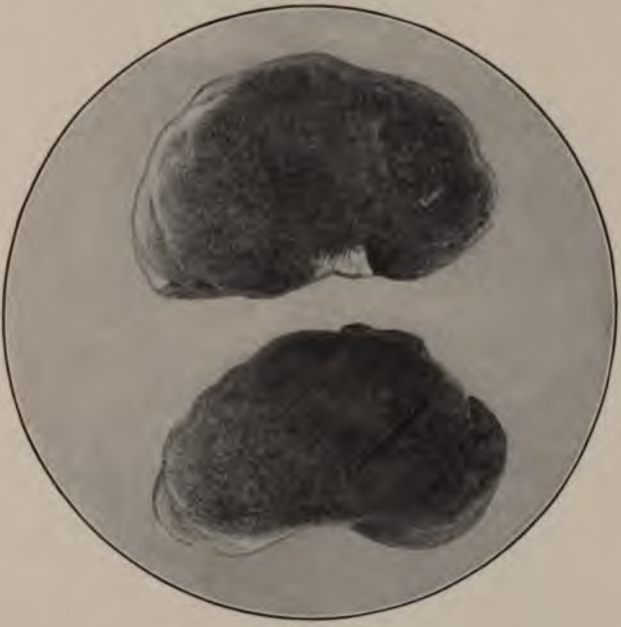

Fig. 7.

tently for about six months. Ten weeks before admission her stomach trouble began, and she vomited frequently. Her dyspnoea started six weeks later, and the oedema commenced one week before entrance. Clinical examination showed marked dyspnoea, slight icterus, coated tongue, an enlargement of the heart to the left, a systolic blowing murmur at the apex, transmitted to axilla and back, also a presytolic murmur, marked general cyanosis and oedema, petechial haemorrhages in skin and mucous membranes. The patient vomited very much, was very restless at times, at others drowsy, had some muscular twitchings in face, and died of gradual circulatory failure. She was distinctly anaemic (3,392,000 reds; 48% Hb.). There was some leucocytosis (12,740).

Fig. 8.

Fig. 9.

Diplostreptococci were obtained in blood culture. Her blood pressure was 100. The temperature was subnormal, with elevations to 99° F. The pulse rate varied between 80 and 100. The urine contained much albumin, many hyaline, granular and cellular casts, many leucocytes and much blood, also diplostreptococci.

Necropsy revealed subacute diplostreptococcic endocarditis of mitral and tricuspid valves, embolic septic foci in heart-muscle, infarcts in spleen and kidney, septic necroses in liver, cholelithiasis, and terminal broncho-pneumonia. The heart was moderately enlarged on the right side on account of mitral disease. The blood-vessels were normal.

The kidneys were swollen (11½ x 6½ x 4 cm.; 12 x 7 x 5 respectively). The capsules stripped easily. The surface was smooth, dark greyish red, and studded with minute haemorrhages. On the cut surface the cortex was wide, distinctly oedematous, and greyish red.

Microscopic sections showed diffuse acute and subacute glomerulonephritis (intra- and extra-capillary); much blood and many leucocytes in tubules, many neutrophilic leucocytes in glomeruli and in interstitial tissue, few eosinophiles and basophiles, comparatively little epithelial degeneration, and beginning proliferation of the connective tissue; arteries normal. No bacteria were found in sections, in spite of careful search.

Case 6. Early subacute glomerulo-nephritis in an infant with congenital syphilis and suppurative colon-bacillus pyelitis.

XVI, 56.— A. C., anaemic female child, 1½ months of age.

The child was apparently normal at birth, was sick for about two weeks with sanguino-purulent discharge from nose, and fever to 101° F. Several blisters developed on abdomen. At the hospital occurred a more general eruption of red blisters. The hands were oedematous on entrance, but the oedema disappeared later. Moist râles were heard over the lungs. The Wassermann reaction was positive. A heavy cloud of albumin was found in the urine, a few doubtful hyaline casts, and many leucocytes. Patient died in collapse with symptoms of pulmonary oedema.

Necropsy revealed syphilitic rhagades at mouth, syphilitic pneumonia and subacute septic pneumonia, syphilitic cirrhosis and miliary syphilomata of the liver, subacute deep ulcerative infection of renal pelvis with colon-bacilli and beginning involvement of kidneys. The arteries were normal.

The kidneys were large. The cortex was opaque and swollen.

Sections showed hyaline necrosis of vascular loops in the majority of the glomeruli, with subacute glomerulitis (extra-capillary). Many

tubules were filled with blood, others contained leucocytes. There was a marked infiltration of the interstitial tissue with neutrophilic, eosino-

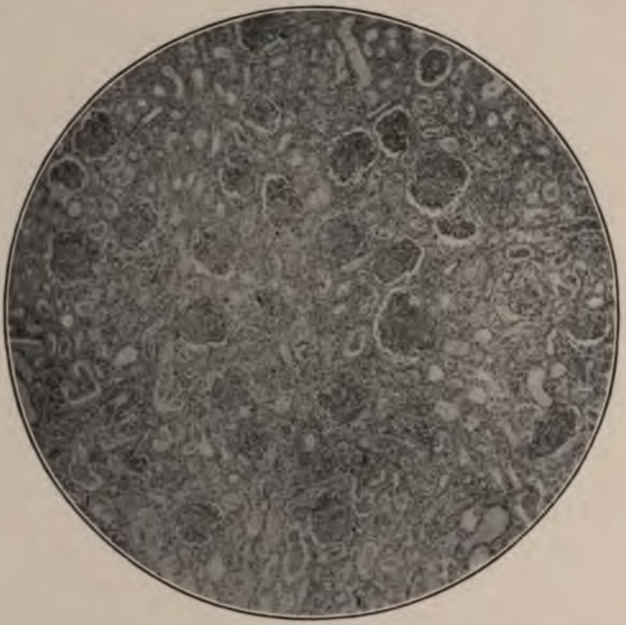

Fig. 10.

philic leucocytes and plasma cells, and cellular proliferation of the connective tissue. The vessels were normal. No bacteria were found in the sections, except at the evidently infected places.

Case 7. Subacute glomerulo-nephritis in a man of 40 years, following subacute endocarditis.

XVII, 163.— E. G., dishwasher, 40 years of age.

Patient had a paralytic stroke associated with left-sided hemiplegia and sensory aphasia seven months before death. He had a chancre two years before, and at the time he came to the hospital had a positive Wassermann reaction. Clinically he showed a systolic murmur at the apex, general oedema, some anaemia (4,800,000 reds, 85% Hb.), and slight leucocytosis (11,200). He had an irregular temperature varying between 96° and 102° F. His pulse rate varied between 70 and 100. His urine contained a moderate amount of albumin and a few hyaline casts.

Necropsy revealed a subacute diplostreptococcic endocarditis of the mitral valve, with regurgitation, an embolic softening in the region of

the right island of Reil, a beginning cyanotic atrophy of the liver, general oedema, marked hydrothorax and normal arteries.

The kidneys were swollen; the cortex was rather wide and opaque, and full of petechial haemorrhages.

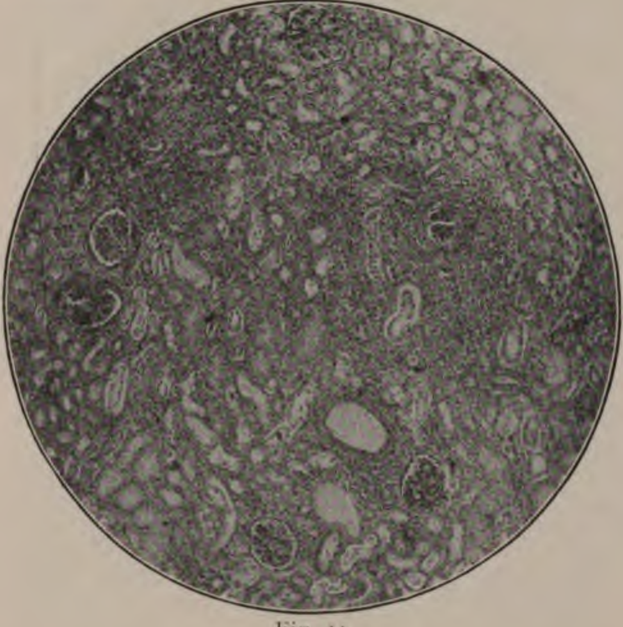

Fig. 11.

Sections showed hyaline necroses in many glomeruli, typical diffuse subacute and more chronic glomerulo-nephritis (intra- and extra-capillary); moderate diffuse cellular thickening of the connective tissue, in which there were quite a few neutrophilic and less numerous eosinophilic and basophilic leucocytes; marked hyperaemia; blood and leucocytes in many tubules; much epithelial degeneration; normal blood-vessels. No pathogenic bacteria were found in the sections.

Case 8. Marked subacute glomerulo-nephritis in a man of 45 years, following streptococcic infection of compound fracture.

XIV, 34.—J. W., strongly built, muscular American carpenter, 45 years old.

Patient had a compound fracture of the left leg eight and one-half months before death. The bones became united, but the wound never quite healed and later broke open, leaving a constantly discharging ulcer

from which a small piece of necrotic bone came away at one time. Many streptococci were found in the infected tissues. The temperature was normal most of the time, but there were sharp rises off and on. His

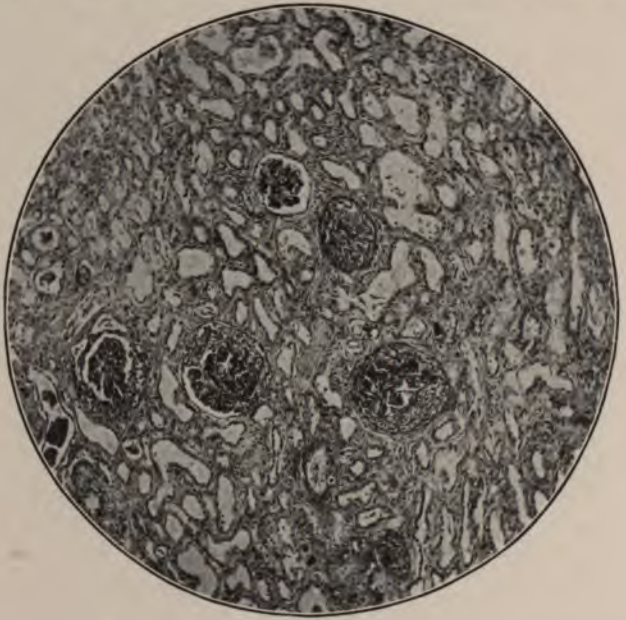

Fig. 12.

urine was smoky, contained much albumin, many hyaline and waxy casts, many red cells.

Necropsy revealed, in addition to the infected fracture, a marked anaemia and broncho-pneumonia, possibly a slight hypertrophy of the left ventricle, slight oedema of leg, slight general arteriosclerosis.

The kidneys were somewhat swollen (12 x 7 x 4 cm.). The surface was smooth, mottled grey and red. The cortex was wide, hyperaemic and oedematous, and full of minute haemorrhages.

Sections showed hyaline necrosis in vascular loops of many glomeruli; very characteristic acute and subacute glomerulo-nephritis (extra-capillary) in practically all; moderate diffuse infiltration of interstitial tissue with neutrophiles, eosinophiles, basophiles, and marked diffuse fibrous thickening of the connective tissue. Many tubules were filled with blood, others with leucocytes. The epithelium showed much fatty degeneration. Slight "arteriosclerosis" in a few of the larger arteries. A few doubtful diplococci were found in the diseased glomeruli and in the leucocytes in some of the tubules.

Case 9. Subacute glomerulo-nephritis in a man of 33 years, following subacute diplostreptococcic endocarditis.

XV, 135.— H. D., strongly built, emaciated, American hospital orderly, 33 years of age.

Patient infected his finger eight months before his death. The infection was followed by chills and fever, increasing weakness, and gradual development of symptoms of septic endocarditis, with remittent fever and progressive anaemia (eventually 3,800,000 reds; 56% Hb., 5,000 leucocytes, and occasional myelocytes). Three months before his death

Fig. 13.

patient noticed oedema at ankles, increased thirst, and increased urination. Since this time he complained of headaches and dyspnoea. The Wassermann reaction was negative. Blood cultures were negative on two occasions. His urine was increased in quantity (specific gravity 1010-1016), showing a heavy cloud of albumin (about 0.5%), many hyaline and granular casts, a moderate number of leucocytes, and at times many red cells. Phenolsulphone-phthalein excretion two weeks before death: 40% in two hours.

Necropsy revealed a subacute aortic diplostreptococcic endocarditis with moderate stenosis and some insufficiency, a purulent mediastinitis,

and a fibrinous pleurisy, both due to the diplostreptococci, a large spleen with a septic infarction, no oedema, normal arteries.

The kidneys were of about normal size; the surface was smooth. The cortex was wide, opaque, intensely hyperaemic, and full of haemorrhages.

Sections showed hyaline necrosis of loops in many glomeruli, very typical subacute glomerulo-nephritis (intra-capillary) in practically all, large areas of cellular infiltration (containing neutrophilic leucocytes), and much fibrous thickening of the connective tissue, with beginning atrophy of the tubules. Some tubules were full of blood, others contained casts. Much granular and fatty degeneration was found in the epithelium, also extensive necrosis. Normal blood-vessels. No pathogenic bacteria were found in sections.

Case 10. Subacute glomerulo-nephritis with continued hypertension and cardiac oedema in woman of 27 years. following abscess of jaw.

XVIII, 106.— M. O. A., poorly nourished Spanish housewife, 27 years old.

Twenty-one months before death, patient had considerable trouble with her teeth, lasting for eight months; finally alveolar abscess developed, and one tooth had to be removed. This abscess involved lower jaw, and had to be drained from outside. She had been apparently well since then, until four weeks before her death, when she developed a painless oedema of the legs, without any other symptoms. The swelling continued, and the abdomen also became involved. Ten days before death, symptoms of an acute infection developed in the right leg. She developed an irregular fever to 102° F; her pulse rate varied between 100 and 140. There was also some leucocytosis (10-15,000). Clinically there were no important findings except oedema and evidences of cellulitis. Her haemoglobin was 80%, her blood pressure 160, gradually rising to 170. Her urine was quite scanty, specific gravity 1010; it contained much albumin, many hyaline and granular casts, many red and white cells. She had no symptoms of uraemia, and died of the acute streptococcic infection of her leg.

Necropsy revealed streptococcic cellulitis of the right leg, bronchopneumonia, some ascites (a pint of fluid), and an acute cystitis. Her left ventricle was slightly hypertrophied. There was no arteriosclerosis except in the renal arteries, where it was of a moderate degree.

Fig. 14.

Fig. 15.

Her kidneys were of about normal size (12 x 5 x 4 cm.); the capsule was slightly adherent; the surface slightly roughened. The cortex was rather wide, yellow, and opaque.

Microscopical sections showed subacute, peri-capillary glomerulonephritis in many glomeruli, with development of fibrous connective tissue between capillaries, hyaline degeneration of the wall of some of the

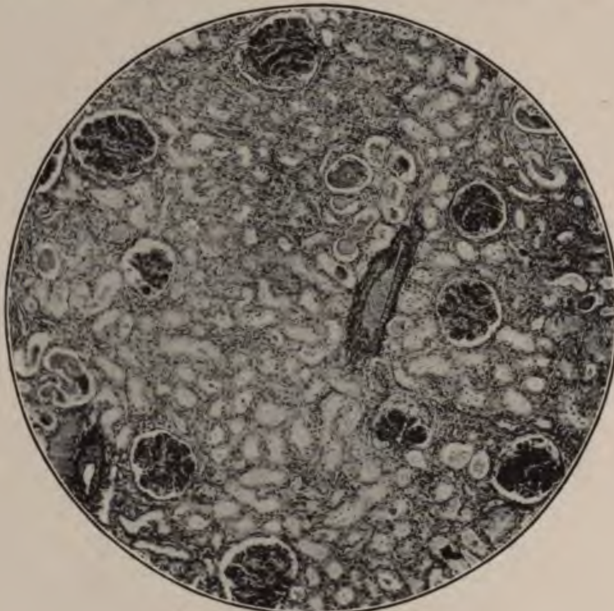

Fig. 16.

capillaries in the tufts, moderate diffuse thickening of the connective tissue with beginning atrophy of some of the tubules, leucocytes in many tubules, many hyaline casts, no haemorrhages, and much epithelial degeneration. The thickened interstitial tissue is almost altogether fibrous. There are very few small areas of lymphocytic infiltration; no granular leucocytes were found in the tissues. No bacteria were found in the sections, in spite of continued search.

Case 11. Late subacute glomerulo-nephritis in a man of 51 years, following chronic diplostreptococcic endocarditis.

XVII, 119.— M. A., well nourished Norwegian male cook, 51 years of age.

Patient began to complain of heart trouble four years before his death. He had had some oedema. He came to the hospital about six

weeks before death, complaining of vomiting and dyspnoea. Clinically, he showed evidence of an enlargement of the heart, and a marked diastolic murmur, also symptoms of aortic aneurysm. The backgrounds of his eyes were normal; there was no definite evidence of uraemia. His temperature was subnormal and slightly irregular. His pulse rate varied between 90 and 100. His blood showed a secondary anaemia (3,312,000 reds, 60% Hb.) and a leucopenia (6200). He had a syphilitic history and a positive Wassermann reaction. His blood pressure, gradually

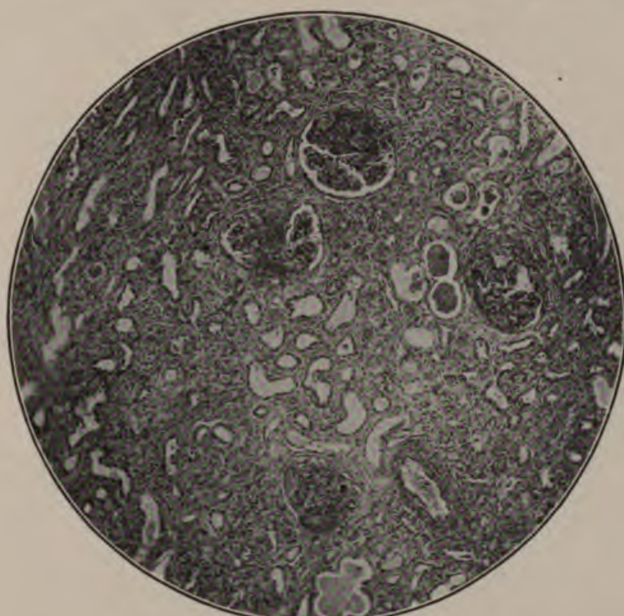

Fig. 17.

rising, varied from 180 to 220. Since over one-half year before death, he had noticed polyuria up to one gallon a day. The polyuria continued while he was at the hospital. His urine contained much albumin, many epithelial and granular casts, a few leucocytes, occasionally many red cells. It had a low specific gravity (1005-1010). There was practically no elimination of phenolsulphone-phthalein in three successive tests.

Necropsy revealed syphilis of the aorta and an aneurysm of the arch; a chronic diplostreptococcic endocarditis on the ventricular side of the large sail of the mitral valve and of the aortic valves with little deformity of the aortic cusps, and acute diplostreptococcic pericarditis, slight ascites, and moderate hydrothorax; old cyanotic atrophy of liver; be-

ginning amyloid degeneration of the spleen, no amyloid in the kidneys. The heart was twice normal size, with a very marked hypertrophy of the left ventricle. The renal and splenic arteries were markedly sclerotic.

The kidneys were slightly enlarged (13 x 7 x 4 cm.), the surface was somewhat rough, dark red, and full of haemorrhages. On the cut surface the cortex appeared slightly reduced and opaque.

Sections showed very marked diffuse, chronic, subacute and acute glomerulo-nephritis (intra- and peri-capillary), with hyaline necrosis of many vascular loops, fibrin in capsules of many glomeruli, much infiltration with granular leucocytes, especially with eosinophiles, and marked diffuse thickening of the connective tissue with atrophy of many tubules; blood, leucocytes, and casts in tubules; much granular degeneration and necrosis of the epithelium; slight "arteriosclerosis" of a few of the small arteries and several of the larger ones. No bacteria were found in sections.

Case 12. Late subacute glomerulo-nephritis in woman of 26 years with repeated attacks of tonsillitis, a general diplostreptococcic sepsis with infection of the urinary tract, multiple thrombotic arterial obstruction.

XVIII, 61.— E. M., frail and extremely emaciated Irish-American housewife, 26 years of age.

Patient had numerous attacks of tonsillitis from infancy to four years before death. She was treated six years before death for nephritis following miscarriage. For the last five years she had much headache, associated with vomiting. Occasionally she had slight oedema of feet and ankles. Four months before death she complained of marked weakness, headaches associated with vomiting, pains in shoulders and arms, loss of power in left arm. She bled easily from her mucous membranes. Left foot had been cyanotic in region of big toe during cold spells for the past two years; she also had attacks of syncope in her fingers. Her eyesight began to fail at this time. When she entered the hospital a month before death, the toes of the left foot were cold and blue and her left arm contracted and atrophied. Later she developed dry gangrene of the left foot. Her tongue was dry and red, her breath uraemic. The heart action was heaving. There was a slight systolic and diastolic murmur, and considerable ascites. She later developed some oedema of the legs. Towards the end there was marked puffiness of the face. She had been complaining of failing eyesight for some time, and ophthalmoscopic examination revealed retinitis albuminurica. Shortly before her death,

she had profuse haemorrhages from the rectum. She died in uraemic coma. Her temperature was irregular, showing alternating periods of slight rises to 100° F, and of subnormal temperature. Her pulse rate was very irregular, varying between 80 and 130. She was very anaemic (Hb. 50%, 3,000,000 reds). Her leucocytes were normal except for a terminal leucocytosis. In a blood culture a pure growth of diplostreptococci was obtained; similar organisms were found in her urine. She denied all venereal infection, and had a negative Wassermann reaction. Her blood pressure was 165 on entrance, went up to 185, and then grad-

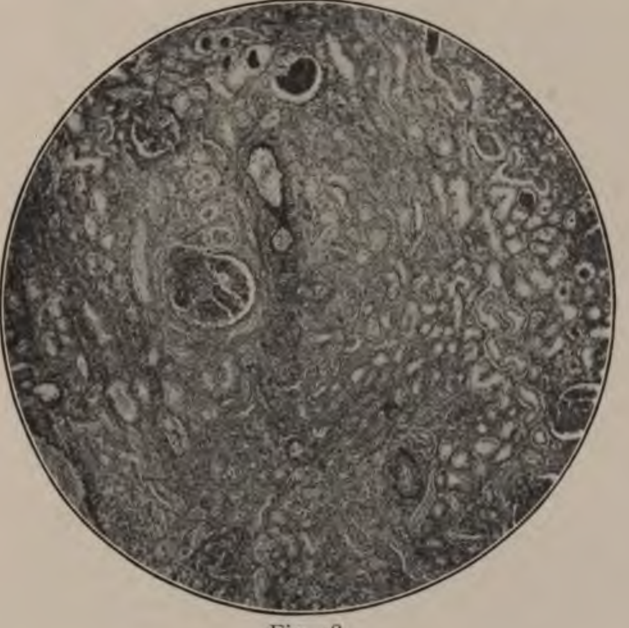

Fig. 18.

ually down to 140. She had had nycturia [7] for the last ten years. Her urine was of about normal amount, of low specific gravity (1004-1008). It contained much albumin, sometimes few, at other times many casts of various kinds, some red blood corpuscles and leucocytes. Towards the end there was much pus in the urine. The phenolsulphone-phthalein secretion was much delayed (12% in two hours).

Necropsy revealed slight oedema of hands and legs, marked ascites. The appendix was surrounded by old adhesions. There was also some

[7] Urination at night.

Fig. 19.

Fig. 20.

peritoneal thickening in the upper part of the abdominal cavity. The liver showed an old cyanotic atrophy. A large, deep, recent ulceration evidently due to arterial obstruction was found in the sigmoid flexure. The heart was of normal size; the left ventricle firm, full of small irregular necrotic spots, due to obstruction of small arteries. There were a few small yellow spots in the aorta. The renal pelves were slightly dilated. They contained a few drops of pus in which there were some diplostreptococci. The bladder also was infected with diplostreptococci. The left arm was contracted, and there was a dry gangrene of the left foot.

The left kidney was of about normal size (10½ x 4½ x 3 cm.), the right kidney smaller. The surface was mottled grey and red, and studded with petechial haemorrhages. The renal tissue was distinctly indurated, and the cortex narrowed to about 3 mm. Unfortunately an examination of the brain and of the peripheral arteries, and a thorough search for an old septic focus, was impossible.

Sections showed marked diffuse, subacute, and chronic glomerulonephritis (intra-capillary form), moderate cellular infiltration, and marked diffuse fibrous thickening of the connective tissue with atrophy of many tubules; much epithelial degeneration and many casts; blood and pus in the tubules, thrombotic hyaline deposits along inside of walls of many arterioles, anaemic necroses in pyramids due to thrombosis of small arteries. Other small arteries showed marked "endarteritis," and all the larger ones moderate "arteriosclerosis." No bacteria were found in sections.

Case 13. Subacute and chronic glomerulo-nephritis in a child of 8 years following infectious aneurysm of aorta.

XVI, 190.— V. P., female child, 8 years of age.

The patient had had measles, pertussis, mumps, and chickenpox. There was no history of sore throat, rheumatism, or scarlet fever. She was apparently perfectly well until about five months before death, when she began to have severe continuous headaches in the frontal region with much vomiting. About three weeks later she had a "spasm" lasting an hour and a half, with tongue bite and twitching of muscles of eyes and face. This was repeated six days later, and again after a few weeks. After the spasms she was unable to see well. The vomiting continued, and she developed increased thirst and polyuria. The patient lost much weight.

Fig. 21.

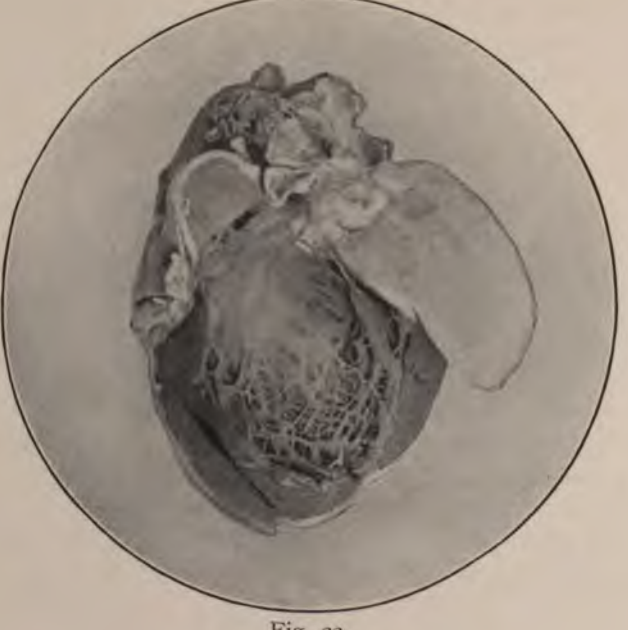

Fig. 22.

Clinical examination three months before death showed neuritis in left eye, enlargement of the heart with loud systolic murmur, painful enlargement of liver, no oedema. Later a papular eruption appeared on the extensor surfaces of extremities and on body. A retinal detachment developed in the left eye. At one time puffiness of the face was noticed. She complained of much pain in the pit of the stomach; nausea and vomiting continued intermittently. She suffered much from dyspnoea, and occasionally had pain in the region of the heart. Signs developed

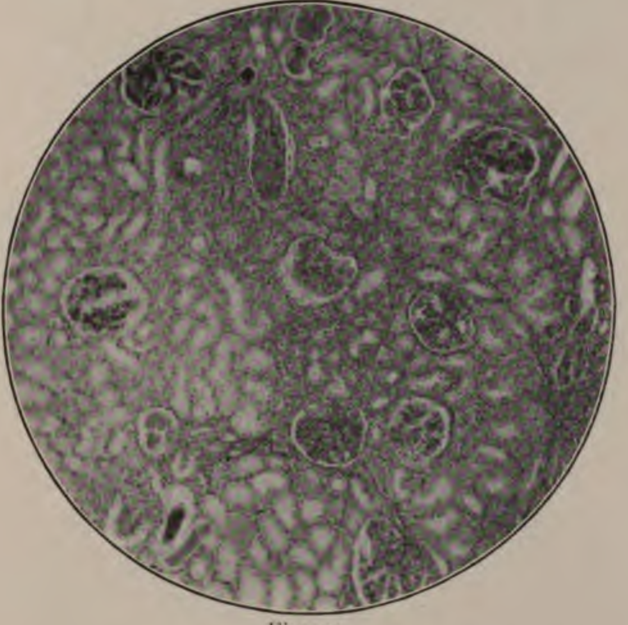

Fig. 23.

of the presence of fluid in the pleural cavities. She had much cough, with blood-tinged sputum. Two months before death, the arteries in both eyes were found *much contracted,* and there was marked optic neuritis and retinitis in both eyes. Her temperature was slightly elevated and irregular. The Wassermann reaction was negative. There was a marked anaemia (Hb. 60%) and some leucocytosis (28,000 gradually decreasing to 10-12,000). The blood pressure was about 140. She had a very marked polyuria all the time; the urine was of low specific gravity (1002-1005). It contained little albumin and few hyaline casts, some leucocytes.

Necropsy revealed an infectious (diplostreptococcic) aneurysm of the upper abdominal aorta, involving the orifice of the left renal artery, which was entirely occluded; infarcts in lungs and spleen; and an old tuberculous focus in the left peribronchial lymph-glands. The heart showed normal valves. It was considerably enlarged, about twice normal size, with marked hypertrophy of the left and dilatation of the right ventricle. The left forearm and hand were oedematous on account of thrombosis of the subclavian vein. There was much chyloid fluid in both pleurae. The arterioles in the spleen were greatly thickened and hyaline. The other arteries were normal.

The left kidney was quite small (8 x 4 x 3½ cm.) with flat purple scars at upper pole and along the convexity. The right kidney was considerably swollen (12 x 5 x 4½ cm.); the cortex was wide, yellow, and opaque.

Sections of the left kidney showed old focal glomerulo-nephritis with numerous scars, no recent processes. Sections of the right kidney showed old glomerulo-nephritis in few glomeruli with scar formation near them; hyaline necrosis and subacute glomerulo-nephritis (intracapillary) in many glomeruli; slight infiltration of interstitial tissue with neutrophilic, eosinophilic, and basophilic leucocytes; considerable proliferation of the connective tissue; much granular degeneration of the epithelium; many casts, and leucocytes in some tubules. The blood-vessels were normal. No pathogenic bacteria were found in sections.

Case 14. Chronic glomerulo-nephritis in a child of 10 years with a history of repeated attacks of tonsillitis.

XVIII, 17.— A. B., poorly developed female child, 10 years of age.

The child had smallpox at an early age and had frequent attacks of tonsillitis. For the last two years she had had attacks of precordial pain, shortness of breath, and vomiting. She had been gradually running down with periods of exacerbation and remissions. She had had transient joint pains at times. Severe disturbance of compensation commenced about two weeks before death with oedema involving the face. Clinical examination one week before death showed a poorly developed, poorly nourished child with very marked dyspnoea, some oedema of the face but none elsewhere, heavily coated tongue, marked enlargement of heart; rapid, regular pulse (gallop rhythm), no murmurs, enlargement and tenderness of liver. A petechial rash appeared on the skin about one week before death. Towards the end she was semi-comatose, very restless (uraemia). There was some anaemia (3,696,000 reds,

Fig. 24.

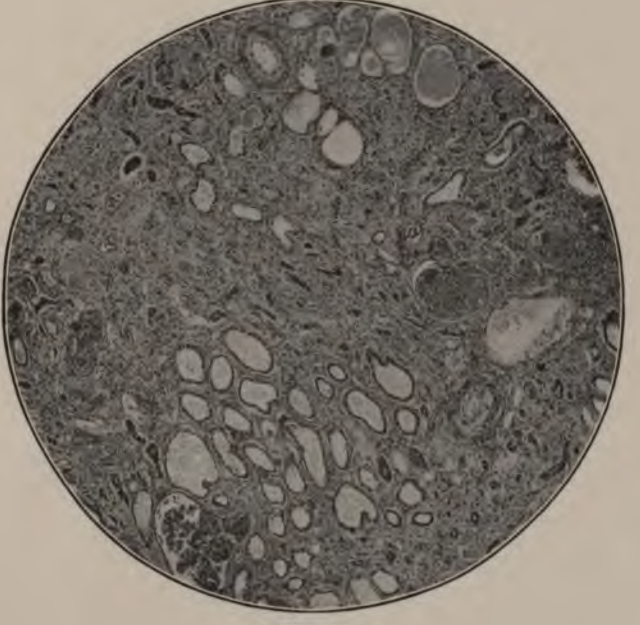

Fig. 25.

Hb. 80%) and a slight leucocytosis (11,400). The temperature was subnormal (about 96° F) with rises to 99° and 100° F. The Wassermann reaction was negative. The urine (quantity could not be determined) showed a specific gravity of about 1010, a heavy cloud of albumin, several hyaline casts, and a few red cells. The blood pressure was 160 on entrance, but later fell to about 145.

Necropsy revealed a recent purulent diplostreptococcic vulvitis, a congenital fold at the lower end of the left ureter with slight hydronephrosis, ascites, hydrothorax, and slight oedema of the legs. The heart was at least twice normal size, with marked hypertrophy of the left ventricle. Except for a few small yellow spots in the abdominal aorta, the arteries were normal.

The kidneys had firmly adherent capsules. They were small (left 6 x 3 x 2 cm., right 9 x 4 x 3 cm.), finely granular, and the cortex was distinctly narrowed.

Sections showed very extensive involvement of glomeruli; some showed recent hyaline necrosis of loops, others typical subacute and chronic glomerulo-nephritis (intra-capillary). There was a marked diffuse thickening of the interstitial tissue, with heavy infiltration with neutrophilic, eosinophilic, and basophilic leucocytes; large areas of cicatrization; blood and leucocytes in few tubules; many casts, much epithelial degeneration; marked "endarteritis" in the small, and moderate "arteriosclerosis" in the large arteries. No pathogenic bacteria were found in sections.

Case 15. Chronic glomerulo-nephritis in boy of 6 years following streptococcic infection of urinary tract in nephrolithiasis.

XV, 120.— E. R., emaciated anaemic boy, 6 years of age.

Two years before the patient's death, a large stone was removed from the bladder. The urine at that time contained pus. The heart was clinically normal. Five months later evidences of cardiac hypertrophy developed. Later he had a right facial palsy. He had to urinate very frequently. The boy gradually went down-hill, and eventually died in uraemic coma. The history is incomplete, and there is no record of urinary analysis.

Necropsy revealed a small stone (1½ cm. in diameter) in right renal pelvis, with streptococcic infection of the urinary tract. The heart was somewhat enlarged, with definite hypertrophy of the left ventricle. Except for a few yellow spots in the aorta and in the coronaries, his arteries were normal.

Fig. 26.

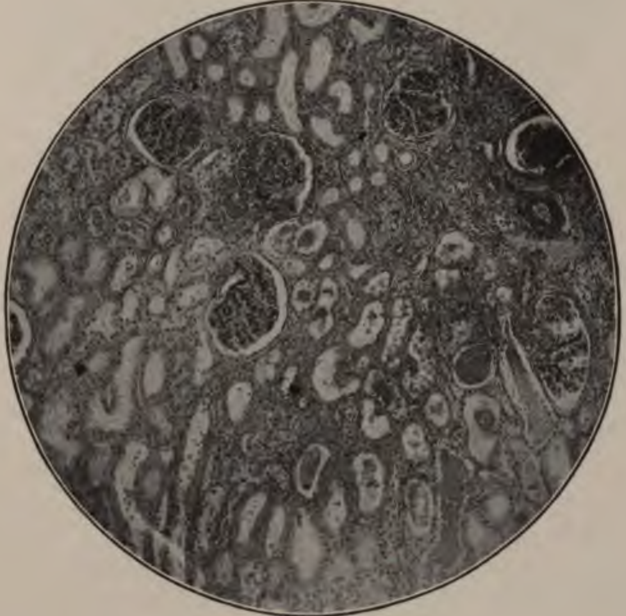

Fig. 27.

The left kidney showed many superficial purple scars, with narrowing of cortex. In other places the cortex was wide and opaque. The right kidney showed much more extensive cicatrization, with small nodules of fairly normal kidney tissue.

Sections showed very extensive chronic glomerulo-nephritis, with complete fibrosis of the glomeruli; large areas of cellular infiltration, and

Fig. 28.

fibrosis, with atrophy of tubules; many hyaline casts in the atrophic tubules. In the comparatively normal parts much recent and subacute glomerulo-nephritis (intra-capillary); and a few granular leucocytes in the tissues. Blood and leucocytes were found in some tubules. Much granular degeneration and necrosis of the epithelium. Hyaline thrombosis along wall in some small arteries. Very marked "endarteritis" in small and larger arteries, especially in the fibrous areas. The sections were too badly contaminated to permit of a bacteriological examination.

Case 16. Chronic glomerulo-nephritis in man of 53 years with diplostreptococcic sepsis (infected atheromatous ulcers in aorta).

XVIII, 70.— M. K., strongly built, fairly well nourished Japanese laundryman, 53 years of age.

(The history is imperfect, because the patient did not speak English, and was observed for a few days only.)

Patient had beri-beri at the age of 33. He was a heavy smoker, and he used much alcohol. For about the last three years his face and feet would become swollen at intervals, especially when he drank heavily, and at these times he complained of distress and of difficulty in breathing. His present attack started seventeen days before his death, with oedema. Later he developed a white membrane in the throat, which first appeared on his tonsils, spreading over the uvula and inside of the cheek. He developed a high fever, and had a very foul breath. Clinical examination showed puffiness of face, slight oedema of legs, angina and stomatitis, an apparently normal heart. The pulse was small, regular, rhythmical, and of low tension. The patient died with the signs of pulmonary oedema. His urine a few days before his death was of a very low specific gravity (1002), contained much albumin, occasional granular casts, and many white and red blood corpuscles.

Necropsy revealed slight oedema of conjunctivae and of cheeks, septic angina and stomatitis (diplostreptococcus infection). In the lower thoracic and in the abdominal aorta there were large atheromatous plaques, many of them ulcerated. In smears from these ulcers many diplostreptococci were found. There was an old thrombosis of the left iliac artery. The other arteries were somewhat dilated, otherwise normal. The spleen was of normal size, and contained many diplostreptococci. The arterioles in the spleen were distinctly thickened. The liver showed an incipient cyanotic atrophy. There were 500 cc. of fluid in the abdomen. The patient died of broncho-pneumonia and beginning pleurisy.

The heart was enlarged (one and one-half times normal size). The wall of the left ventricle was greatly thickened (16 mm. in diameter).[8] The heart muscle showed a marked fatty degeneration.

The kidneys were of about normal size (11 x 6 x 5 cm.), with granular surface. The tissue was greyish, with red blotches. Small petechial haemorrhages could be made out on the surface. On the cut surface the cortex was found distinctly narrow and opaque. The mucous

[8] Measured from base of trabeculae carneae to outer surface.

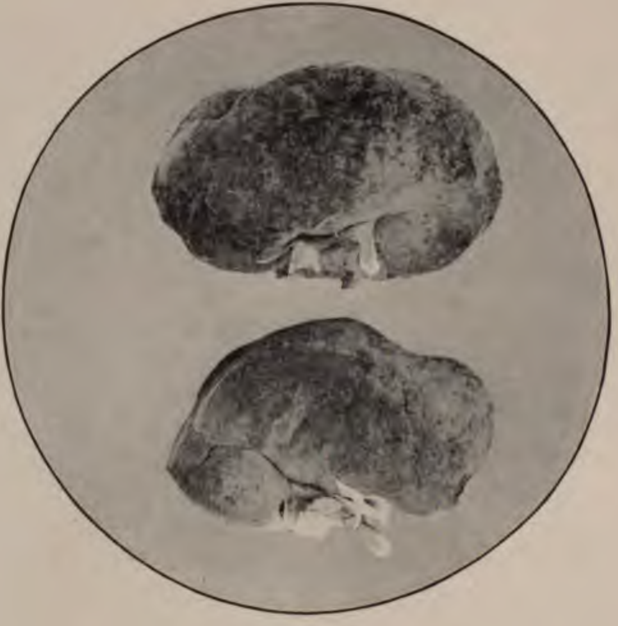

Fig. 29.

Fig. 30.

membrane of the renal pelvis and of the bladder was hyperaemic. Few diplococci were found in smears from the renal pelvis. Few diplococci were found in smears from the kidney tissue.

Microscopical sections showed a subacute and chronic diffuse intra- and extra-capillary glomerulo-nephritis, marked cellular infiltration and fibrous thickening of the interstitial tissue, with atrophy of many tubules; many neutrophilic leucocytes, much epithelial degeneration, and many

Fig. 31.

casts. Diplostreptococci were found in many capillaries and in the inflamed connective tissue near them; none were seen in the glomeruli or elsewhere. Many arterioles were either filled or lined on the inside with hyaline thrombus; sometimes these hyaline masses were found above, sometimes underneath the endothelial lining. In other arterioles there was a marked endarteritis, probably as a result of organization of these hyaline masses; others again showed a marked "arteriosclerosis." The large arteries showed a marked "arteriosclerosis."

Case 17. Chronic glomerulo-nephritis in man of 48 years with a history of scarlet fever and rheumatism.

XVI, 257.— J. McL., fairly well nourished Scotch butcher, 48 years old.

Patient had scarlet fever as a child, rheumatism at about the age of 20. Eight years before death he had pleurisy. For the last two and one-half years he had often had chills in the evening and night sweats; since that time he had also noticed shortness of breath and oedema. One year before death he observed puffiness of the face. At times he had

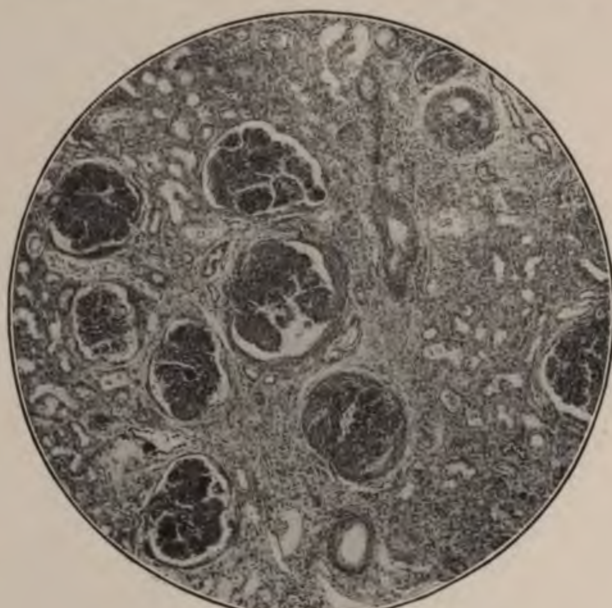

Fig. 32.

slight pains around the heart, radiating toward the arms. He complained of failing eyesight and frontal bilateral headaches. For these complaints he had been at the hospital off and on, where a peripheral arteriosclerosis, a cardiac enlargement with systolic and diastolic murmurs, was made out, and a severe anaemia (3,000,000 reds, 50% Hb.). He had a negative Wassermann reaction. Eight months before death his blood pressure was 200. At his last entrance it was 210, gradually falling to 165. Eight months before his death, examination of the fundus of the eyes showed an old disseminated syphilitic choroiditis, well defined arteriosclerosis, and evidence of former optic neuritis. The last

month he was more or less unconscious, at times delirious and noisy, and towards the end had several uraemic convulsions. While at the hospital his temperature and pulse were normal. He had had nycturia (six to seven times a night) for several years. His urine was greatly increased in quantity, to two liters and more, showed a fixed low specific gravity; contained much albumin and usually many hyaline and granular casts, and many leucocytes.

Necropsy revealed a large heart, twice the size of the fist; general oedema and hydrothorax; a marked general arteriosclerosis, and almost complete closure of the right coronary artery. The kidneys were of about normal size, granular.

Sections showed very marked, diffuse chronic and subacute intracapillary glomerulo-nephritis, with unusually extensive hyaline necroses of the vascular loops; many large areas of cellular infiltration, and marked diffuse cicatrization with atrophy of many tubules; few granular leucocytes; casts in many tubules; leucocytes in some. There was some fatty degeneration and necrosis of the epithelium; and hyaline masses in many small arteries causing sometimes complete obstruction. Marked "endarteritis" and marked "arteriosclerosis" were found both in the small and in the large arteries. The sections were badly contaminated with colon bacilli.

Case 18. Chronic glomerulo-nephritis with recent exacerbation, in man of 45, of unknown etiology.

XVI, 212.— A. L., well nourished Danish male cook, 45 years of age.

The history is imperfect, because the patient entered the hospital in a dazed condition and could not give a clear account of himself. He claimed to have been suffering for about two years from headache, dizziness, loss of memory, failing eyesight, shortness of breath, progressive weakness, and frequent urination. He never had oedema.

Clinical examination showed symptoms suggestive of partial sensory aphasia, a marked peripheral arteriosclerosis, enlargement of heart with accentuation of second aortic tone, lessened reflexes on the left side of the body, and horizontal nystagmus to the left. His blood was normal except for a slight leucocytosis (11,000 whites, 82% neutrophiles). The Wassermann reaction was negative on repeated tests, both in blood and spinal fluid. His blood-pressure was constantly very high, varying from 235 to 280. He had a retinitis albuminurica; towards the end he had convulsions. Shortly before death a petechial rash developed in the skin on hands, chest, and back. Towards the last there was some oedema of

the eyelids. He died in uraemic coma. His urine was increased in quantity, pale, clear, of low specific gravity, and contained much albumin, many hyaline and granular casts.

Necropsy revealed a heart which was somewhat enlarged (about one and one-fourth normal size), with small scars in the wall of the

Fig. 33.

left ventricle. There was a rather well marked general arteriosclerosis involving aorta, cerebral and coronary arteries, the small arteries in spleen and pancreas, and many others.

The kidneys were small (11 x 5 x 3 cm.) and full of small haemorrhages. The cortex was quite narrow, hyperaemic, and opaque.

Sections showed marked diffuse chronic and subacute glomerulonephritis (intra-capillary), with hyaline necroses in vascular loops; large areas of cellular infiltration, and fibrous thickening of the connective tissue with atrophy of tubules; blood and leucocytes in many tubules; much epithelial degeneration, few casts; marked thickening of intima both in small and in large arteries, partly with hyperplastic development of elastic tissue, partly without. The sections also showed numerous small old necrotic foci,—situated near badly affected glomeruli with thrombotic obstruction of vasa afferentia,—in which the capillaries were

hyperaemic, and showed much fibrin in and near them, which became hyaline eventually. Many granular leucocytes were found in and about such foci. Some of them showed beginning organization. No bacteria were detected in sections, in spite of especially careful search.

Case 19. Chronic glomerulo-nephritis in man of 37 years. No old septic focus found, but a diplostreptococcic infection of the rectum of unknown duration, and a terminal(?) diplostreptococcic sepsis.

XVI, 10.— J. M., well nourished Mexican sailor, 37 years of age.

Patient claims to have always been healthy and well, denies any diseases of childhood. He suffered from "asthma," for the first time four years before entrance. Two months before death he had aching pains in neck, back, and extremities, which were worse at night. He had a syphilitic history and a positive Wassermann reaction. Clinical examination showed an enlargement of the heart and a soft systolic murmur, ascites, proctitis, general oedema. Towards the end he developed a marked dyspnoea. There were no definite uraemic symptoms. His temperature showed slight occasional rises, and his pulse varied from 80 to 100. His blood pressure was 182. He had a marked anaemia (2,350,000 reds; 50% Hb.), and on entrance to the hospital (two months before death) a leucocytosis (18,000), which disappeared later. His urine contained a moderate amount of albumin, few hyaline and granular casts, and later many red cells.

Necropsy revealed a muco-purulent proctitis due to diplostreptococcic infection. Few diplostreptococci were found in liver, spleen, kidneys, and lungs. There was also a terminal parotitis. The heart was one and one-half times normal size, with a very marked concentric hypertrophy of the left ventricle (14 mm.). The arteries, including the cerebral arteries, were normal, except the renals, which showed a marked arteriosclerosis. There was also present a general oedema, ascites, hydrothorax, and a cyanotic atrophy of the liver.

The kidneys were small (10 x 5 x 3½ cm.), the surface was finely granular, mottled purple and grey. No haemorrhages were seen. The cortex was moderately narrowed and opaque; the markings were poor.

Sections showed mostly chronic glomerulo-nephritis; recent hyaline necroses in few glomeruli; large areas of cellular infiltration and cicatrization with atrophy of tubules; few granular leucocytes; some tubules filled with casts, blood and leucocytes. The epithelium was filled with

Fig. 34.

Fig. 35.

pigment in places and showed much fatty and granular degeneration. Hyaline deposits in the walls of many small arteries, apparently under-

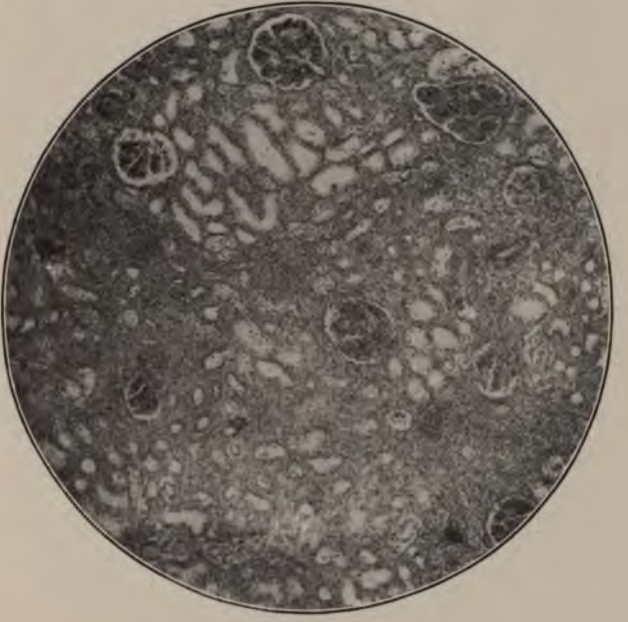

Fig. 36.

neath endothelium. Beginning "endarteritis" in the small arteries connected with diseased glomeruli, moderate "arteriosclerosis" in the larger arteries. No bacteria were found in sections.

Case 20. Chronic glomerulo-nephritis in Japanese of 35 years with old diplostreptococcic infection of tonsils.

XVIII, 167.— M., strongly built, well nourished Japanese farmer, 35 years of age.

Patient was admitted to hospital five days before his death, complaining of pains all over body, and of drowsiness. The first symptoms of renal disease were observed four years before, when he had general oedema and ascites, and was told that he had kidney disease. Two months before death swelling returned slightly, but disappeared again; since then he noticed shortness of breath and pains all over the body. For some days before admission he had headache, and vomited several times. Clinical examination showed semi-stupor, considerable puffiness around the eyes, heavily coated tongue and foul breath, normal heart-

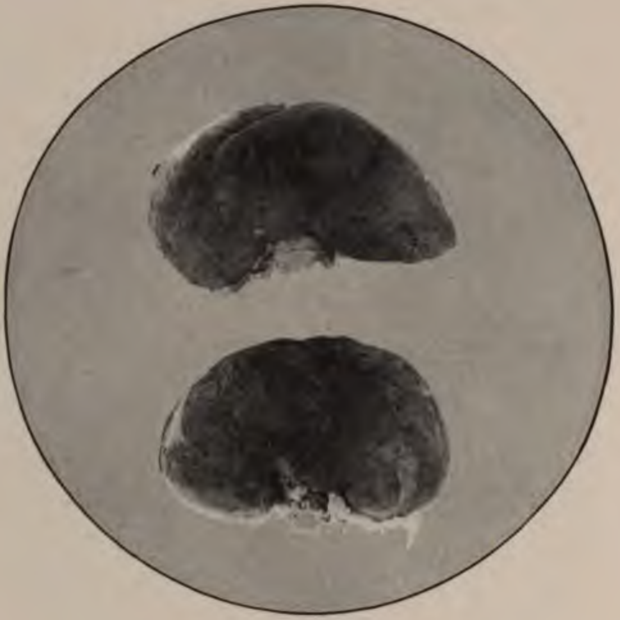

Fig. 37.

Fig. 38.

dullness, systolic murmur at base, accentuated second aortic tone, marked general hyperaesthesia, especially of muscles, and scaly skin. The temperature was normal. His pulse rate was rather slow, averaging about 64. His blood-pressure, during the last days of his life, was 115. He had a severe anaemia (2,804,000 reds; 43% Hb.) with poikilocy-

Fig. 39.

tosis and anisocytosis and some leucocytosis (18,000). The Wassermann reaction was negative both in blood and spinal fluid. Towards the end the patient had occasional attacks of severe dyspnoea, in one of which he died (uraemia). His urine was of low specific gravity (1010), contained much albumin, and in one specimen many granular casts and leucocytes.

Necropsy revealed chronic tonsillitis with old pus-pockets in crypts (diplostreptococcic infection). The heart was about one and one-half times normal size (left ventricle not dilated, averaged 12 mm.). The aorta was markedly atheromatous; the other arteries, including renals, were normal.

The kidneys were small (9½ x 4½ x 3½ cm.). The capsules were thickened and adherent. The surface was somewhat rough and quite pale. On the cut surface the cortex was distinctly narrowed (to 2-3 mm.) and opaque.

Microscopic sections showed diffuse, chronic, intra-capillary glomerulo-nephritis, more subacute lesions in few glomeruli, marked diffuse fibrosis with large areas of cellular infiltration, some of which contain many neutrophilic and basophilic leucocytes, marked atrophy of many tubules, compensatory enlargement of others, little epithelial degeneration, blood and leucocytes in many tubules, also many hyaline casts, slight "arteriosclerosis" of arterioles in most fibrous areas, moderate "arteriosclerosis" of larger ones. No bacteria were found in the sections, in spite of careful search.

Case 21. Chronic glomerulo-nephritis in woman of 36 with old scar in base of aorta, old pericarditis, septic thrombosis of left auricle, and old septic infarct in spleen containing influenza bacilli.

XVI, 260.— Mrs. K., emaciated English housewife, 36 years of age.

Patient's health was good until she was 22, when she had a severe infection ("touch of typhoid"). Since she was 23 years old, she had spells of intense headache, vomiting, nausea, and occasional nose-bleeds. She had oedema at times. Eight years before death, premature delivery in eighth month of pregnancy became necessary on account of albuminuria. Before the birth of her second child, two years later, there was much oedema. She suffered much from severe dyspnoea, pains over heart and kidneys, and sleeplessness. In the last months she had much stomatitis and tonsillitis. Towards the end she was very weak, restless, and delirious (uraemia). The pleurae had to be tapped several times for hydrothorax. She had a marked anaemia (3,500,000 reds; 65% Hb.) and a normal leucocyte count. Her temperature was normal, her pulse rate quite varying, sometimes increased to 120 or over. Her respiration was about 30. Her blood-pressure varied between 160 and 190. She urinated once at night. Her urine on frequent examination had a low specific gravity and contained a heavy cloud of albumin (0.5% or over), many granular and hyaline casts; blood was found on one occasion. Phenolsulphone-phthalein was slowly excreted (20 resp. 11% first hour, 15 resp. 21% second hour).

Necropsy revealed an old scar in one of the sinus Valsalvae, a healed pericarditis, septic thrombi in left ventricle and left auricle, an old septic infarct in spleen (many influenza bacilli in thrombi and in infarct), marked oedema and slight hydrothorax. The heart was one and one-half times normal size. The left ventricle measured 13 mm., and was

Fig. 40.

Fig. 41.

firm. The renal arteries were moderately sclerosed, the others practically normal.

The kidneys were small (10 x 5 x 3 and 8½ x 4½ x 2½ cm. resp.); the capsule was adherent; the surface distinctly granular; the cortex much reduced (to 3 mm. in places). The tissue was soft, oedematous,

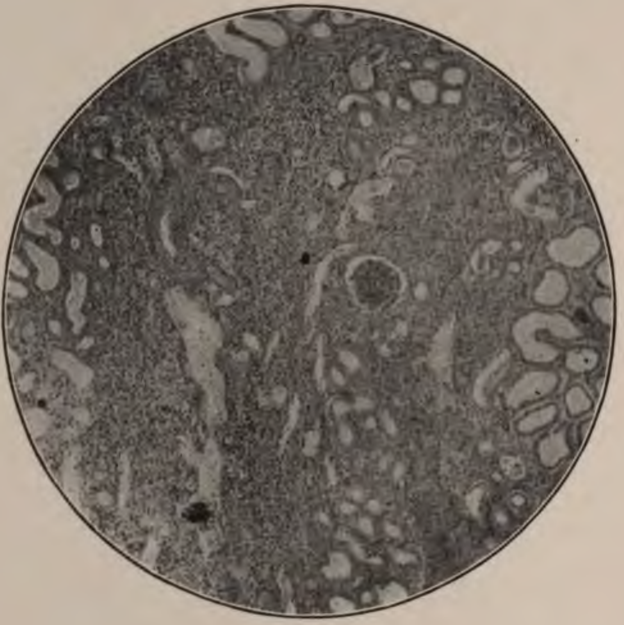

Fig. 42.

and full of opaque spots. There were few haemorrhages in the cortex of the right kidney.

Sections show mostly chronic, but also some recent, glomerulo-nephritis (intra-capillary); large areas of cellular infiltration and fibrous thickening of the connective tissue with atrophy of tubules; few granular leucocytes; little blood in tubules; granular and fatty degeneration of the epithelium, moderate number of casts; much hyaline underneath endothelium in several small arteries; marked "endarteritis" of the small arteries and moderate "arteriosclerosis" of the larger ones. No pathogenic bacteria were seen in sections.

Case 22. Chronic glomerulo-nephritis in man of 42 years with old tuberculosis and continued suppuration of the lymph-glands of the neck.

XVII, 184.— R. M., poorly nourished Scotch clerk, 42 years of age.

Patient had had chronic tuberculosis of lymph-glands of neck since childhood, which necessitated twelve operations. For the last three years before entrance he had had occasional nycturia; for the past three weeks he had been easily fatigued, and suffered from indigestion; and

Fig. 43.

for the past ten days he noticed shortness of breath, cedema of legs, and oliguria. On clinical examination he showed a very marked dyspnoea and cyanosis, very poor teeth, slight enlargement of heart, a soft systolic murmur at apex, petechiae on right arm and left thigh, marked oedema of lower extremities. The peripheral arteries appeared sclerotic. Later he developed pericardial friction and signs of pleurisy. Towards the end the patient was very dyspnoeic and drowsy, sometimes delirious, and showed muscular twitching. He died in uraemic coma. He was anaemic (3,160,000 reds; 62% Hb.); he had a leucocytosis (14-25,000 leucocytes, 90% neutrophiles). His blood-pressure varied from 200 to 235.

Fig. 44.

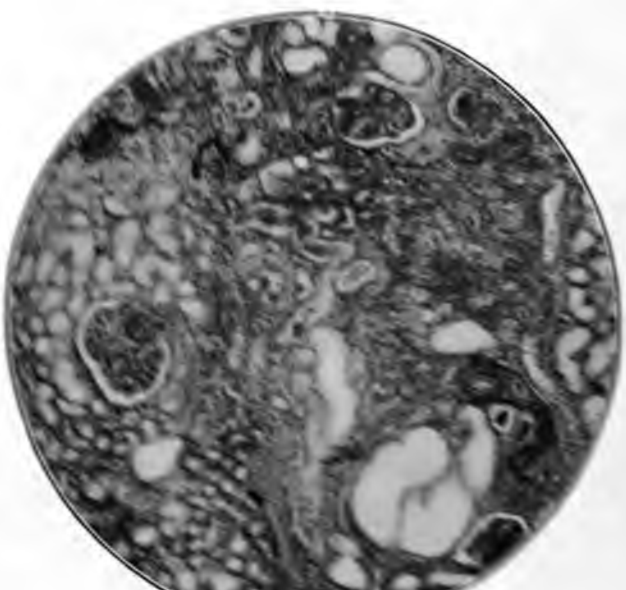

Fig. 45.

His temperature was subnormal (97° F), with rises to 99° F. His urine while at hospital was scanty, of low specific gravity, and contained much albumin, many hyaline, epithelial, and granular casts; no blood was found.

Necropsy revealed numerous old scars on neck and slight remnants of old tubercular infection, recent haemorrhagic diplostreptococcic pericarditis and pleurisy, broncho-pneumonia. The heart was one and one-half times normal size (left ventricle averaged 14 mm.). The renal arteries were moderately sclerosed, the others practically normal.

The kidneys were small (10 x 4 x 3 cm.), the capsule firmly adherent, surface granular, small haemorrhages in cortex, which was much reduced (4 mm.). The markings were indefinite.

Sections showed chronic glomerulo-nephritis in the majority of the glomeruli; more recent changes in a few; diffuse cicatrization with small areas of cellular infiltration; few granular leucocytes; many casts in collapsed tubules; leucocytes in some of the tubules; little epithelial degeneration; hyaline in few small arteries; marked "endarteritis" in many small arteries; marked "arteriosclerosis" in few small and all larger arteries. No pathogenic bacteria were found in sections.

Case 23. Chronic glomerulo-nephritis in man of 55 with chronic endocarditis.

XVII, 116.— J. H., well nourished Canadian sailor, 55 years of age.

Patient had repeated attacks of tonsillitis, was in hospital three years before death for rheumatism; reëntered shortly before death with acute rheumatism of hands. There was no history of syphilis. The Wassermann reaction was negative. Patient had "epileptic" attacks at various times, last one three months before death. He complained of shortness of breath, increasing dimness of vision, cramps in legs, and deep pains in bones. He never had any oedema.

Clinical examination showed marked nervousness, hacking cough, contracture in left leg, arteriosclerosis of radial artery, heart within normal limits, a soft systolic murmur, no oedema. The backgrounds of his eyes showed small, slightly tortuous arteries, otherwise they were normal. Towards the end he had bleeding from nose and mouth, vomited daily, and developed uraemic coma. His blood-pressure varied from 190 to 210. He had a severe anaemia (2,150,000 reds; 30% Hb. anisocytosis), no leucocytosis. His temperature was subnormal. His pulse rate varied between 70 and 95. His urine was scanty, of low specific gravity,

contained much albumin, many granular casts, few leucocytes, few red cells.

Necropsy revealed an old endocarditis of the mitral valve. The heart was somewhat enlarged. There was a terminal broncho-pneumonia.

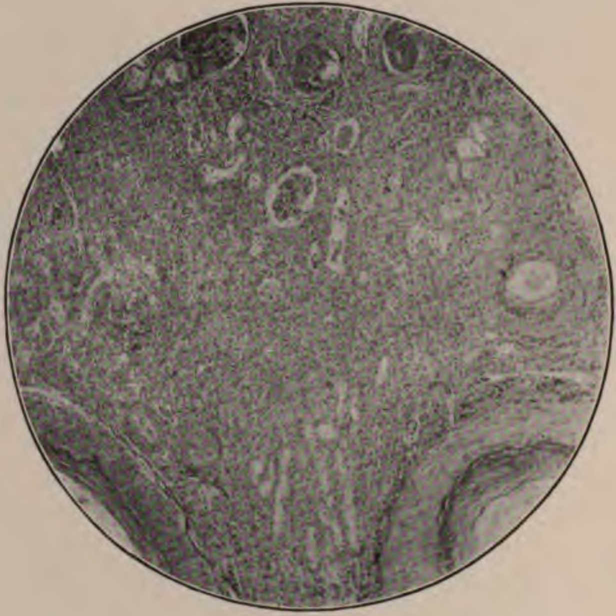

Fig. 46.

The radial artery showed a marked arteriosclerosis; the others were much less involved.

The kidneys were small and pale; the capsule adherent, surface granular, cortex narrow, full of cysts.

Sections show chronic glomerulo-nephritis in many glomeruli (intracapillary), more recent lesions in few; very extensive cicatrization of cortex with much cellular infiltration; few granular leucocytes; much epithelial degeneration and many casts; leucocytes in few tubules; much subendothelial hyaline in many small arteries; marked "endarteritis" in most small arteries, more "arteriosclerotic" lesions in others; very marked "arteriosclerosis" of larger arteries. No pathogenic bacteria were found in sections.

Case 24. Chronic practically healed glomerulo-nephritis in man of 61 with old history of rheumatism.

XVII, 164.— D. G., emaciated French male cook, 61 years of age.

Patient had rheumatism when he was young. He denied all venereal disease. His present illness began two years ago with loss of weight (35 lbs.), shortness of breath, and increasing weakness. He had to void his urine at night two to three times.

Clinical examination showed a marked puffiness of skin about eyes, much dyspnoea, coated tongue, and foul breath, enlarged heart, a rough

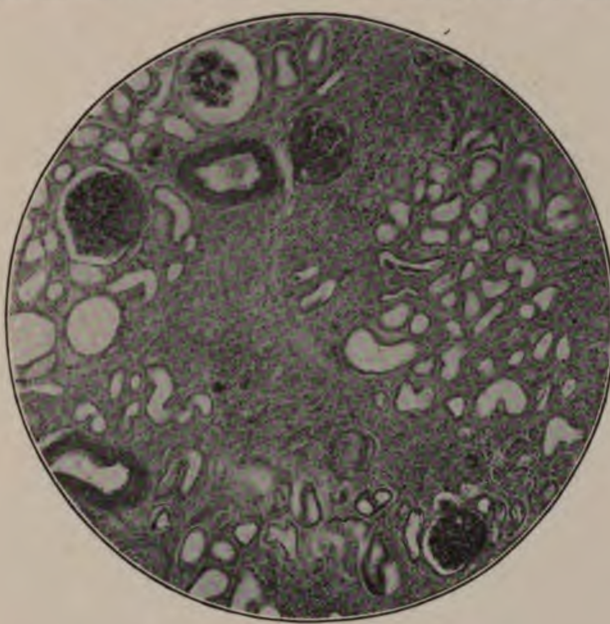

Fig. 47.

systolic and faint diastolic murmur over the heart. The rhythm of the heart was absolutely irregular. His liver was enlarged. His blood-pressure on entrance was 170, later gradually went down to 137. Patient had no marked oedema at any time. He had a severe anaemia (3,500,-000 reds and 48% Hb.), also a slight leucocytosis (14,600). The Wassermann reaction was negative. The urine was scanty at first, later about normal in quantity. The specific gravity was about 1010. It contained considerable albumin, and at times many granular casts and red cells. The patient at no time showed definite symptoms of uraemia. He died with the clinical symptoms of an acute pulmonary infection.

Necropsy revealed marked general arteriosclerosis, a very marked enlargement of the heart (about three times normal size), small scars in heart muscle, gouty deposits in kidneys and toe joints, a terminal broncho-pneumonia, beginning cyanotic atrophy of liver.

The kidneys were small (10½ x 4 x 4 cm.); the capsule stripped easily. The surface was coarsely granular. The cortex was much reduced, and the markings were very indistinct.

Sections show chronic glomerulo-nephritis in many glomeruli with large areas of cicatrization in cortex, comparatively little cellular infiltration, few granular leucocytes; subacute glomerulo-nephritis (intra-capillary) in few glomeruli; leucocytes in few tubules; little epithelial degeneration; very marked "arteriosclerosis" of large and small arteries. No bacteria were found in sections.

Case 25. Chronic glomerulo-nephritis, in man of 60 years, of unknown etiology.

XVIII, 108.— T. H. D., poorly nourished man, 60 years of age.

No history could be obtained on account of the condition of the

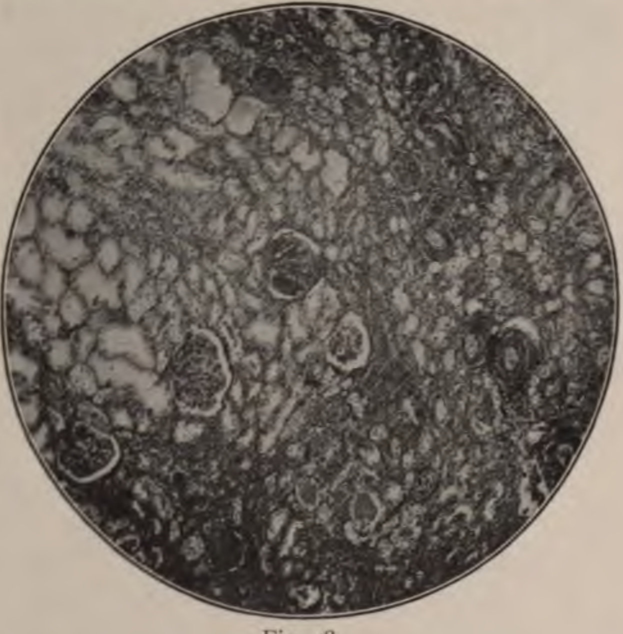

Fig. 48.

patient. Patient entered the hospital in a delirious condition. He showed a coarse tremor of the extremities, a jerking of the head, and consider-

able rigidity of the neck. The reflexes were exaggerated. There was an infected wound over the occiput. His temperature ranged between 97.6° and 99.5° F. His pulse was high and irregular. He had no oedema. He died three days later in coma.

Necropsy revealed a beginning prostatic hypertrophy and terminal broncho-pneumonia. His heart was of normal size. There was a slight concentric hypertrophy of the left ventricle. All arteries, the aorta and cerebral vessels included, showed a marked arteriosclerosis.

The kidneys were small (9.7 x 4 x 2.3). The capsule stripped with difficulty. The surface was granular. The cortex was narrow and opaque. There were no visible haemorrhages.

Microscopical sections showed very extensive old glomerulo-nephritis of many glomeruli, much cellular infiltration and fibrous thickening of the connective tissue with atrophy of groups of tubules, much epithelial degeneration, many casts and leucocytes in tubules, considerable pigmentation of the epithelium. The arterioles and the larger arteries showed a very marked "arteriosclerosis."

Case 26. Chronic glomerulo-nephritis, in man of 54 years, of unknown etiology.

XVIII, 19.— S. G., emaciated Irish teamster, 54 years of age.

Patient did not recall any diseases except measles in infancy. He was a heavy beer drinker. He had gonorrhoea at 35, denied lues. Five years before death he became dropsical for the first time; he had another attack one year ago, associated with "rheumatism." He complained of dropsy, shortness of breath, palpitations, and precordial pain, headache, and pains in legs.

Clinical examination showed marked drowsiness, marked oedema of face, coated tongue, poor condition of few remaining teeth, enlargement of heart, distant heart sounds but no definite murmurs, ascites, general oedema. Towards the end he became delirious, and died in uraemic coma. His blood-pressure varied between 190 and 210. He had some anaemia (78% Hb.), no leucocytosis. His temperature was normal and at times subnormal. His pulse rate varied between 80 and 130. His urinary output varied between 1400 and 2500 ccm. daily. The specific gravity was low. The urine contained a heavy cloud of albumin, occasional hyaline casts, few leucocytes, no blood. There was practically no excretion of phenolsulphone-phthalein.

Necropsy revealed a slightly enlarged heart (left ventricle averaged 12 mm.), marked arteriosclerosis of coronaries and of all abdominal arteries, cyanotic atrophy of the liver, much oedema, ascites and hydro-

thorax, recent haemorrhagic pericarditis without bacterial findings. He also had gouty joints.

The kidneys were small (8½ x 3½ x 3 cm.); the capsule was thick and adherent; the surface granular. The cortex was much reduced (to about 3 mm.) and full of cysts; the markings were poor.

Sections showed chronic glomerulo-nephritis in many and subacute lesions in few glomeruli; large areas of cellular infiltration and fibrous

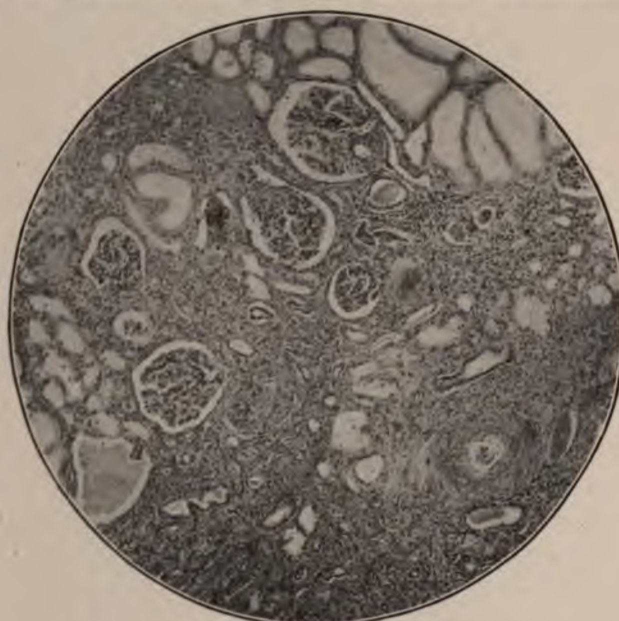

Fig. 49.

thickening of the connective tissue with atrophy of the tubules; moderate infiltration with neutrophilic leucocytes, few eosinophiles and basophiles; slight epithelial degeneration, many casts in atrophic tubules; subendothelial hyaline in few small arteries; marked "arteriosclerosis" and "endarteritis" in small arteries, marked "arteriosclerosis" in large arteries. No bacteria were found in sections.

Case 27. Chronic glomerulo-nephritis in man with old "malaria" and terminal septic lesions.

XVII, 82.— C. S., well nourished American male nurse, 31 years of age.

The history is imperfect. "He had 'malaria' two and one-half years ago which was recurrent." He had syphilis at the age of 26, and several attacks of gonorrhoea.

Fig. 50.

Fig. 51.

Necropsy revealed an ulcerative diplostreptococcic stomatitis, an acute suppurative pericarditis without bacterial findings, and an acute endocarditis of the mitral valve. The heart was one and one-fourth times normal size, and the left ventricle averaged 15 mm. There was a marked arteriosclerosis of the aorta, coronaries, splenic, renal, and cere-

Fig. 52.

bral arteries. The liver showed cyanotic atrophy with compensatory hypertrophy of the peripheral parts of the lobules.

The kidneys were small (8½ x 4 x 3 cm.) and granular, showing grey spots on a red background. There were many haemorrhages in the cortex. The latter was much reduced. Some gouty deposits were found in the pyramids.

Sections showed chronic glomerulo-nephritis of most glomeruli and more subacute lesions (intra-capillary) in a few; almost total destruction of the cortex by fibrosis, much cellular infiltration; few granular leucocytes; blood and leucocytes in many tubules, much epithelial degeneration, many casts: "endarteritis" in few small arteries, very marked "arteriosclerosis" in the rest. No bacteria were found in sections.

Case 28. Chronic glomerulo-nephritis in man of 24 years with chronic endocarditis.

XVII, 149.— L. A., well nourished Italian boxmaker, 24 years of age.

The patient's general health had been good until one year before his death, when he had rheumatism in feet and hands. His present illness started four months ago with epistaxis, shortness of breath and pain in the epigastrium.

Clinical examination showed continued bleeding from nasal mucous membrane, a heavily coated tongue, very marked dyspnoea in spite of comparatively little circulatory disturbance (uraemic air hunger), mod-

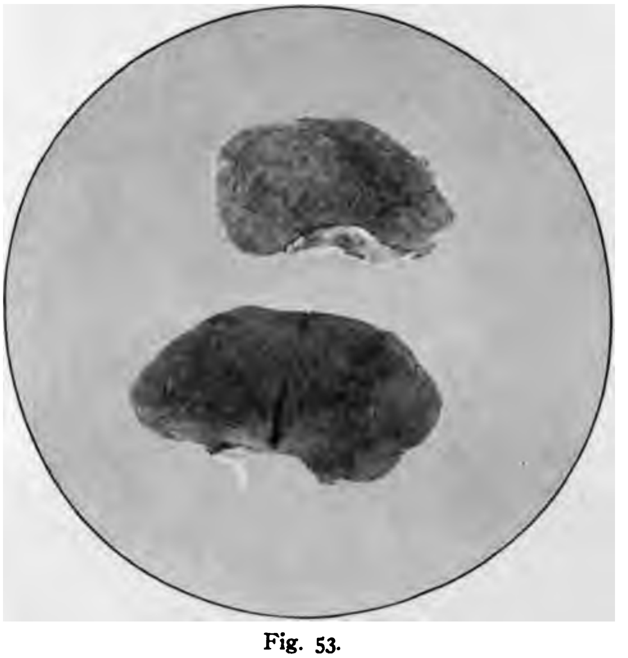

Fig. 53.

erate dilatation of the heart towards the right, a presystolic murmur, normal rate and rhythm of heart beat. Patient had no oedema at any time. He had a severe anaemia (3,100,000 reds; 48% Hb.); towards the end much leucocytosis (39,600; 93% neutrophiles). Blood culture was negative. His temperature was subnormal. For the last one and one-half months he voided urine four to five times at night. It was of low specific gravity (1011) and contained much albumin; no casts. (One examination, as patient was in hospital one day only.) No coma.

Fig. 54.

Fig. 55.

Necropsy revealed an old endocarditis of the mitral valve with moderate stenosis (no bacteria found), recent apparently embolic pustules on chin and left hand, a heart of normal size on the left, slight dilatation on the right side; an old primary tuberculosis of the intestines and of the mesenteric lymph-glands. The arteries were normal.

The kidneys were small (9½ x 4½ x 3 and 7 x 4 x 2½ cm., respectively). The capsule was adherent; surface coarsely granular, cortex very narrow, opaque, very light in color, almost yellow.

Sections show chronic glomerulo-nephritis in many glomeruli, more recent changes (intra-capillary) in few; large areas of fibrosis with atrophy of tubules; few areas of cellular infiltration; considerable number of eosinophiles, fewer neutrophiles and basophiles; many casts, few leucocytes in some tubules; little epithelial degeneration; marked "endarteritis" of small arteries, slight "arteriosclerosis" of the larger ones. No bacteria were found in sections.

Case 29. Chronic glomerulo-nephritis in man of 59 years with possibly old septic focus in urinary tract.

XVI. 189.— S. G., emaciated Chinese male cook, 59 years of age.

The history is incomplete, because patient did not speak English. He had noticed puffiness of the face, shortness of breath, palpitation and pain over heart, and swollen legs for the last four to five months. He vomited occasionally, but had no headaches. Clinical examination showed poor teeth, a normal heart, and oedema of the lower extremities. He had a very marked anaemia (2,100,000 reds; 35% Hb.), no leucocytosis. His temperature was subnormal. His pulse rate varied between 60 and 80. The urine (one examination) contained a moderate amount of albumin, no casts, many epithelial cells, and few leucocytes.

Necropsy revealed a small heart, normal arteries except some atheroma of the aorta and moderate arteriosclerosis of the renal arteries, beginning cyanotic atrophy of liver, general oedema, marked ascites and hydrothorax; gouty deposits in ears, basal joints of great toes, and kidneys; purulent cystitis and prostatitis.

The kidneys were very small (8 x 3½ x 2½ and 7 x 3½ x 2½ cm., respectively); the capsule was adherent, the surface granular, the cortex very narrow (2-3 mm.).

Sections showed chronic glomerulo-nephritis of most glomeruli, more sub-acute lesions (intra-capillary) in others, considerable hyaline necrosis in affected glomeruli; very extensive cicatrization of cortex

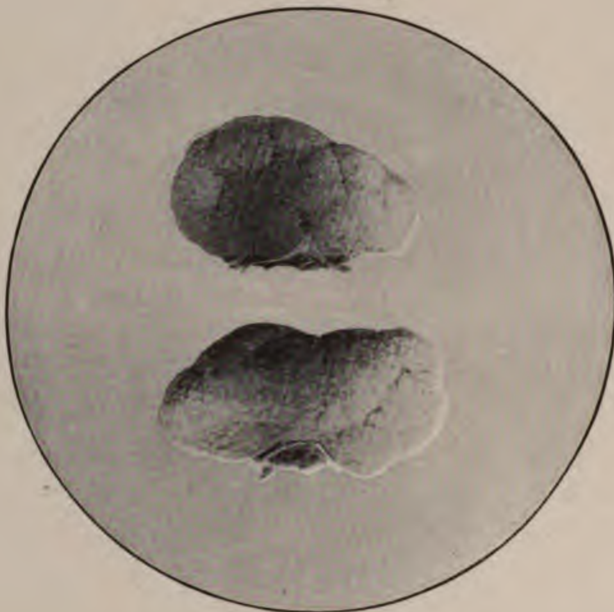

Fig. 56.

Fig. 57.

with some areas of cellular infiltration; very few granular leucocytes; much epithelial degeneration; very many casts, blood in some tubules;

Fig. 58.

very marked "arteriosclerosis" of the small arteries, less in the large ones. No pathogenic bacteria were found in sections.

Case 30. Chronic glomerulo-nephritis in man 38 years of age with a history of repeated attacks of tonsillitis.

XV, 33.— J. C., strongly built boilermaker and bartender, 38 years old.

Patient had been subject to strain and bad weather for twenty-five years. He had frequent attacks of sore throat and many colds. He had used alcohol to excess. He had gonorrhoea and chancroid at 24. When he was 30 he had an attack of "rheumatism" in the right great toe; about one year before his death he had "rheumatism" in several joints and facial palsy following pain at base of skull. Clinical examination showed marked anaemia, coated tongue, bad teeth, heart within normal limits, no murmurs. No oedema. At the hospital he had a fit of "epilepsy." He had a suspicious Wassermann reaction. His blood-pressure was 160. He had a severe anaemia (2,700,000 reds; 35% Hb. no leuco-

cytosis). His temperature was slightly subnormal. His pulse rate varied from 84 to 100. The last three days he had continued epistaxis. He had to void urine frequently and to get up several times at night. Urinanalysis (one examination) showed specific gravity of 1023, no albumin, few granular casts, leucocytes and erythrocytes.

Necropsy revealed purulent bronchitis and broncho-pneumonia, haemorrhagic pleurisy and pericarditis. The heart was slightly enlarged

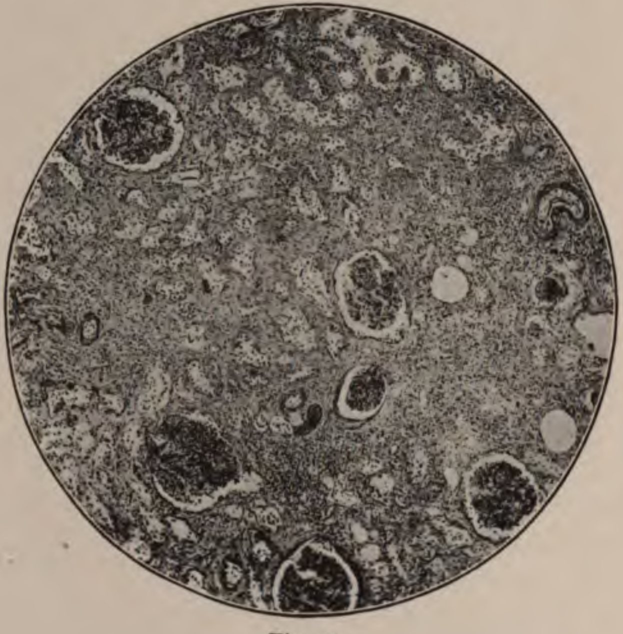

Fig. 59.

(left ventricle averaged 12 mm.). The blood-vessels were practically normal. There were gouty deposits in toe joints and kidneys.

The kidneys were small (9½ x 4 x 2½ cm.) and granular. The cortex was much reduced, and the markings were indefinite.

Sections show chronic glomerulo-nephritis in the majority of the glomeruli, more subacute lesions (intra-capillary) in the few remaining ones, very marked diffuse cicatrization of cortex—with little cellular infiltration; few small, fairly intact areas of kidney tissue; much epithelial degeneration, many small epithelial cysts; blood and leucocytes in few tubules; hyaline masses in few small arteries; marked "arteriosclerosis" of many arterioles; moderate "arteriosclerosis" in larger arteries.

Case 31. Chronic glomerulo-nephritis in woman of 28 years with old ulcer of tonsil and chronic diplostreptococcic infection of urinary tract.

XVII, 68.— Mrs. G. E., emaciated American domestic, 28 years of age.

Patient had always been in poor health; had "La Grippe" as a girl; had had chronic catarrh for many years. Nine years before death appendectomy was performed for acute appendicitis. She had kidney

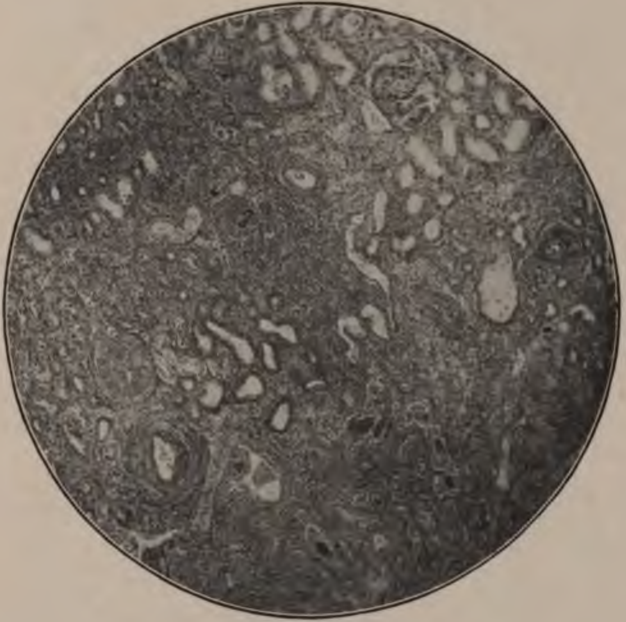

Fig. 60.

trouble while carrying her first child, five years before death, again when carrying the second. About one year before death she noticed progressive debility with anorexia and vomiting. A little later she had some attacks of violent delirium with complete unconsciousness. She voided much pale urine. For the last seven months she had headache, vomiting, jerking and cramps in legs, palpitations of the heart, progressive weakness and loss of weight, progressive amaurosis, and at times oedema of the feet; towards the end patient was very noisy, restless, and delirious.

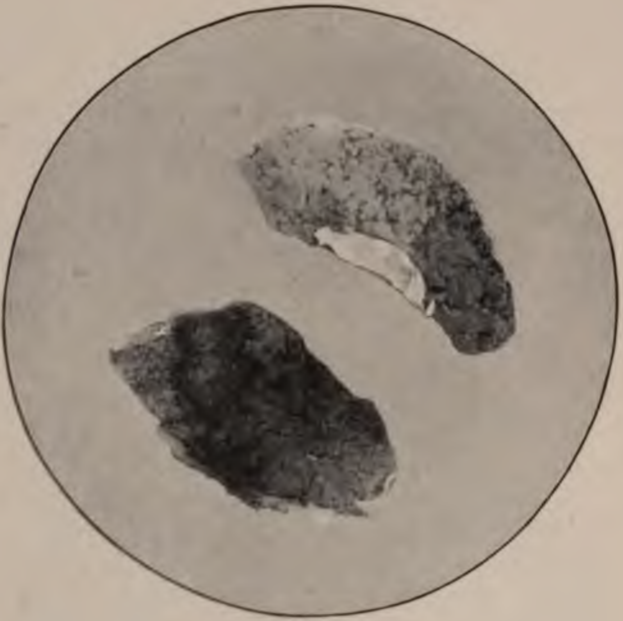

Fig. 61.

Fig. 62.

Her tongue was heavily coated and her breath uraemic. Her temperature was normal, her pulse varied greatly (between 80 and 120). Ophthalmoscopic examination showed an albuminuric retinitis. Her blood-pressure was 185. She died in uraemic coma. She had a marked anaemia (2,700,000 reds; 40% Hb.), some leucocytosis (14,000), 86% neutrophiles. The Wassermann reaction was negative. The phenolsulphone-phthalein excretion was diminished (1. hour 5%; 2. hour 25%). The urine was increased in quantity, of low specific gravity (1010 or less), contained much albumin (to 2%), occasional showers of casts, few red cells, and few leucocytes.

Necropsy revealed a heart about one and one-half times normal size (left ventricle averaged about 11 mm.), normal blood-vessels, an old ulcer of the tonsil, chronic diplostreptococcic cystitis and pyelitis (diplostreptococci also found in right kidney), haemorrhagic fluid in both pleurae and terminal broncho-pneumonia.

The kidneys were very small, especially in antero-posterior diameter (9 x 4 x 3 cm.), coarsely granular, full of large retracted scars; the cortex was very narrow and full of opaque spots.

Sections showed mostly chronic glomerulo-nephritis, more recent lesions in few glomeruli (intra-capillary); large areas of cicatrization with much cellular infiltration; few granular leucocytes; moderate epithelial degeneration; many casts, blood and leucocytes in some tubules; marked "arteriosclerosis" of small, less so of large arteries. No bacteria were found in sections.

Case 32. Chronic glomerulo-nephritis in man of 24 years with indefinite septic history.

XV, 97.— G. A., emaciated Canadian jockey, 24 years of age.

History imperfect. Patient when a boy had "malaria" several times, a definite attack of rheumatism one year before death. When 19 he had a chancre without secondaries. He had been losing weight, had frequent nose-bleed, and was markedly anaemic. His temperature was subnormal.

Necropsy revealed a rather small heart, normal blood-vessels, slight ascites, more marked hydrothorax, no subcutaneous oedema, and terminal broncho-pneumonia.

The kidneys were very small (8½ x 3½ x 2 and 7½ x 3½ x 3 cm., respectively); the capsule was firmly adherent; the cortex was thin and opaque, and full of yellow spots.

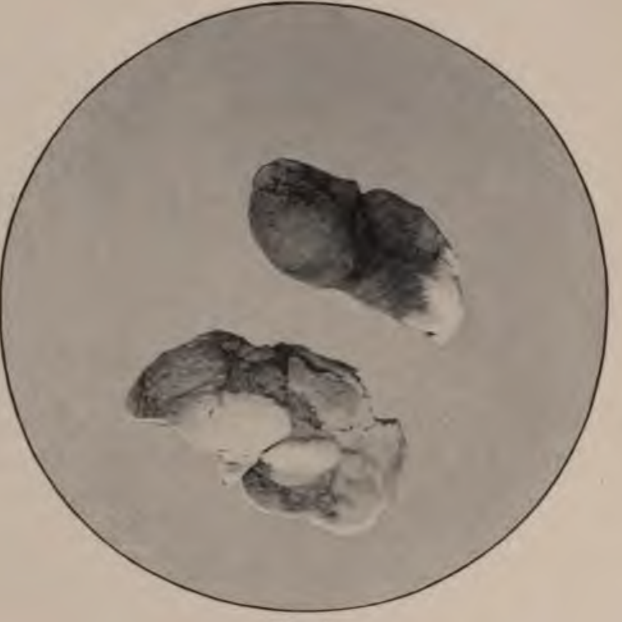

Fig. 63.

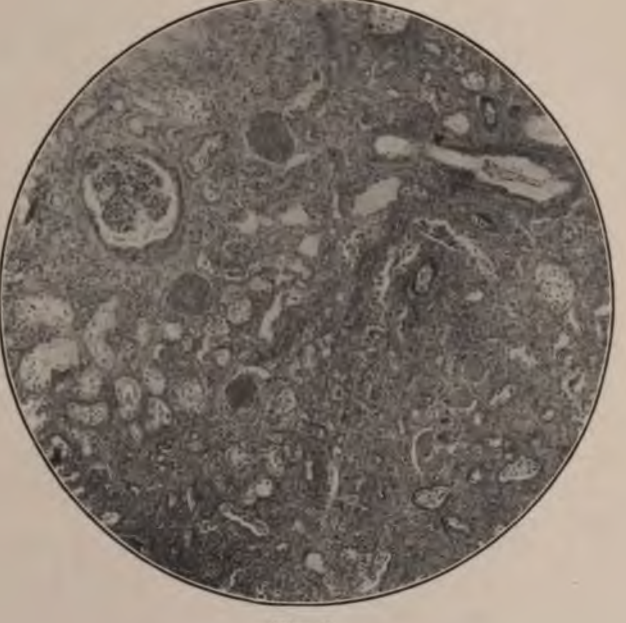

Fig. 64.

Sections showed chronic glomerulo-nephritis of practically all glomeruli,—much hyaline in the affected glomeruli; almost complete destruction of cortex by cicatrization, many large areas of cellular infiltration; much epithelial degeneration, moderate number of casts, blood, and leucocytes in some tubules; moderate "endarteritis" and "arteriosclerosis" in small vessels, slight "arteriosclerosis" in large ones. The sections were too badly contaminated to permit of bacteriological examination.

SUMMARY OF CASES OF

I. ACUTE

Case No.	Sex and Age	Etiology	Condition of Kidney
1. xvii, 60	M, 52	Diplostreptococcic endocarditis.	Swollen, opaque, few haemorrhages (12 x 6 x 3)
2. xvii, 31	M, 54	Diplostreptococcic endocarditis.	Normal size, many haemorrhages
3. xvii, 188	M, 41	Diplostreptococcic endocarditis.	Much swollen, opaque, few haemorrhages (13 x 7 x 4½)
4. xviii, 158	F, 33	Streptococcic ulcers of legs.	Distinctly swollen, hyperaemic, oedematous (12½ x 6 x 4½)

II. SUBACUTE

Case No.	Sex and Age	Etiology	Condition of Kidney
5. xviii, 166	F, 33	Diplostreptococcic endocarditis.	Swollen, many haemorrhages (12 x 7 x 5)
6. xvi, 56	F, 2 mo.	Colon bacillus pyelitis.	Swollen, opaque
7. xvii, 163	M, 40	Diplostreptococcic endocarditis.	Swollen; cortex wide, opaque, many haemorrhages
8. xiv, 34	M, 45	Streptococcic infection.	Swollen, opaque, mottled, many haemorrhages (12 x 7 x 4)
9. xv, 135	M, 33	Diplostreptococcic endocarditis.	Normal size, cortex wide, opaque, many haemorrhages
10. xviii, 106	F, 27	Abscess of jaw.	Normal size, cortex wide, yellow, opaque
11. xvii, 119	M, 51	Diplostreptococcic endocarditis.	Swollen, many haemorrhages, cortex opaque
12. xviii, 61	F, 26	Tonsillitis	Slightly reduced in size, many haemorrhages (10½ x 4½ x 3)

III. SUBACUTE AND CHRONIC

Case No.	Sex and Age	Etiology	Condition of Kidney
13. xvi, 190	F, 8	Infectious aneurysm, diplostreptococcic.	Rt. kidney swollen, pale, opaque; left contracted (8 x 4 x 3½)
14. xvii, 17	F, 10	Tonsillitis.	Small, granular (6 x 3 x 2; 9 x 4 x 3); cortex narrow
15. xv, 120	M, 6	Streptococcic cystitis and pyelitis.	Small, with large deep scars

GLOMERULO-NEPHRITIS

GLOMERULO-NEPHRITIS.

Condition of Urine				Hypertension and Cardiac Hypertrophy	Arteriosclerosis, Local and General	Oedema	Uraemia	Retinitis albuminurica	Anaemia
Albumin	Casts	Erythrocytes	Leucocytes						
+++	+++	—	—	—	loc.+ gen.+	card.	—	—	+
+	+	—	—	—	loc.+ gen.+	card.	—	—	+
+++	+++	—	—	—	loc.+ gen.–	++	—	—	?
+++	+++	—	+++	—	loc.+ gen.–	+	—	—	++

GLOMERULO-NEPHRITIS.

+++	+++	+++	+++	—	loc.– gen.–	+	+	—	++
+++	?	—	—	—	loc.– gen.–	+	—	—	—
++	+	—	—	—	loc.– gen.–	+	—	—	+
+++	+++	+++	+	Sl. hypert. of left ventricle?	loc.+ gen.+	+	—	—	++
P+++	+++	++	++	—	loc.– gen.–	+	—	—	++
+++	+++	++	++	B.P. 170; H. sl. h.	loc.+ gen.–	++	—	—	+
P+++	+++	++	++	B. P. 200; H. 2x	loc.+ gen.+	+	—	—	++
+++	+++	++	++	B. P. 180; H. n.	loc.++ gen.++	++	+	+	++

GLOMERULO-NEPHRITIS IN CHILDREN.

P+	+	—	+	B. P. 140; H. 2x	loc.– gen.–	+	+	?	+
+++	+	+	—	B. P. 150; H. 2x	loc.++ gen.–	++	+	—	+
P ?	?	?	?	H. hyp. left.	loc.++ gen.–	—	+	—	+

…ITIS

Leucocytes	Hypertension and Cardiac Hypertrophy	Arteriosclerosis, Local and General	Oedema	Uraemia	Retinitis albuminurica	Anaemia
[illegible]	(?) H. 1½x	loc.++ gen.+	++	—	—	?
[illegible]	B.P. 200; H. 2x	loc.++ gen.++	++	[illegible]	?	++
[illegible]	B.P. 250; H. 1¼x	loc.++ gen.++	+	+	+	—
—	B.P. 182; H. 1½x	loc.++ gen.–	++	—	—	++
[illegible]	B.P. 115; H. 1½x	loc.+ gen.–	++	+	—	++
[illegible]	B.P. 180; H. 1½x	loc.++ gen.–	++	+	—	++
[illegible]	B.P. 230; H. 1½x	loc.++ gen.–	+	+	—	++
[illegible]	B.P. 200; H. 1¼x	loc.+++ gen.+	—	+	—	++
—	B.P. 170; H. 3x	loc.+++ gen.+++	+	—	—	++
?	B.P. (?); H. n.	loc.+++ gen.+++	—	+	—	?
[illegible]	B.P. 200; H. 1¼x	loc.+++ gen.+++	+	+	—	+
[illegible]	B.P. (?); H. 1¼x	loc.+++ gen.++	?	?	—	?
—	B.P. (?); H. n.	loc.++ gen.–	—	—	—	++
[illegible]	B.P. (?); H. sm.	loc.+++ gen.+	++	+?	—	++
[illegible]	B.P. 160; H. 1¼x	loc.+++ gen.–	—	+?	—	++
[illegible]	B.P. 185; H. 1½x	loc.++ gen.–	+	++	+	++
?	B.P. (?); H. sm.	loc.+ gen.–	+	?	—	++

loc., local; gen., general; card., cardiac. +, slight; ++, moderate;

Case No.	Sex and Age	Etiology	Condition of Kidney
16. xviii, 170	M, 53	Diplostreptococcus sepsis.	Normal size, slightly granular, mottled, some haemorrhages
17. xvi, 257	M, 48	Rheumatism.	Normal size, granular
18. xvi, 212	M, 45	(?) History imperf.	Small (11 x 5 x 3), many haemorrhages; cortex narrow
19. xvi, 10	M, 37	Diplostreptococcus sepsis (?).	Small (10 x 5 x 3½), mottled; cortex narrow, opaque
20, xviii, 167	M, 35	Tonsillitis.	Small (9½ x 4½ x 3½), pale; cortex narrow, opaque
21. xvi, 260	F, 36	Old infection with influenza-bacilli	Small (9 x 5 x 3), granular, cortex narrow, opaque, few haemorrhages
22. xvii, 184	M, 42	Chronic tuberculosis and suppuration of glands	Small (10 x 4 x 3), granular; cortex narrow, few haemorrhages
23. xvii, 116	M, 55	Old endocarditis	Small, pale, granular; cortex narrow, cystic
24. xvii, 164	M, 61	Rheumatism	Small (10½ x 4 x 4), granular; cortex very narrow
25. xviii, 108	M, 60	(?) No history	Small (10 x 4 x 2½), granular; cortex narrow, opaque
26. xviii, 19	M, 54	(?)	Small (8½ x 3½ x 3), granular; cortex narrow, cystic
27. xvii, 82	M, 31	(?) History imperf.	Small (8½ x 4 x 3), granular; many haemorrhages
28. xvii, 149	M, 24	Old endocarditis	Small (8 x 4 x 3), granular; cortex narrow, pale
29. xvi, 189	M, 59	(?) History imperf.	Small (8 x 3 x 2½), granular; cortex very narrow
30. xv, 33	M, 38	Tonsillitis	Small (9½ x 4 x 2½), granular; cortex very narrow
31. xvii, 68	F, 28	Tonsillitis	Small (9 x 4 x 3), granular; cortex very narrow
32. xv, 97	M, 24	Old sepsis suspected	Small (8½ x 3½ x 2), granular; cortex very narrow

Key to abbreviations: M, male; F, female; P, polyuria; B. P., blood-pressure; +++, marked; —, negative; ?, unknown or questionable. All measurements

Condition of Urine				Hypertension and Cardiac Hypertrophy	Arteriosclerosis, Local and General	Oedema	Uraemia	Retinitis albuminurica	Anaemia
Albumin	Casts	Erythrocytes	Leucocytes						
+++	+	++	++	(?) H. 1½x	loc.++ gen.+	++	—	—	?
P+++	+++	—	++	B.P. 200; H. 2x	loc.++ gen.++	++	+	?	++
P+++	+++	—	—	B.P. 250; H. 1¼x	loc.++ gen.++	+	+	+	—
++	+	+	—	B.P. 182; H. 1½x	loc.++ gen.-	++	—	—	++
+++	++	—	++	B.P. 115; H. 1½x	loc.+ gen.-	++	+	—	++
P+++	+++	—	?	B.P. 180; H. 1½x	loc.++ gen.-	++	+	—	++
+++	+++	—	—	B.P. 230; H. 1½x	loc.++ gen.-	+	+	—	++
+++	+++	+	+	B.P. 200; H. 1¼x	loc.+++ gen.+	—	+	—	++
++	++	+	—	B.P. 170; H. 3x	loc.+++ gen.+++	+	—	—	++
?	?	?	?	B.P. (?); H. n.	loc.+++ gen.+++	—	+	—	?
P+++	+	—	+	B.P. 200; H. 1¼x	loc.+++ gen.+++	+	+	—	+
?	?	?	?	B.P. (?); H. 1¼x	loc.+++ gen.++	?	?	—	?
P+++	—	—	—	B.P. (?); H. n.	loc.++ gen.-	—	—	—	++
++	—	—	+	B.P. (?); H. sm.	loc.+++ gen.+	++	+?	—	++
P—	+	+	+	B.P. 160; H. 1¼x	loc.+++ gen.-	—	+?	—	++
P+++	+	+	+	B.P. 185; H. 1½x	loc.++ gen.-	+	++	+	++
?	?	?	?	B.P. (?); H. sm.	loc.+ gen.-	+	?	—	++

H, heart; loc., local; gen., general; card., cardiac. +, slight; ++, moderate; in centimeters.

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Bone and Joint Studies

I

BY

LEONARD W. ELY
Associate Professor of Surgery (Orthopedics)

AND

JOHN FRANCIS COWAN
Assistant Professor of Surgery

(From the Laboratory of Surgical Pathology, Stanford Medical School)

STANFORD UNIVERSITY, CALIFORNIA
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EXPERIMENTAL RESECTION OF THE DOG'S KNEE-JOINT

By Leonard W. Ely and John Francis Cowan
Illustrations by Frank Blaisdell

On the assumption that resection of the dog's knee would result in bony union, this work was undertaken primarily with the idea of studying the histological changes in the bone and marrow following the bony union. This assumption apparently is at the base of most of the work which has been done in experimental arthroplasty. When it be-

Sagittal section of normal knee of dog.

came clear that bony union did not always result, our study was directed to the changes that took place.

Our material consisted of twenty-one dogs. Most of the dogs appeared young. Dog 6 was old. The first dog died under the anaesthetic, probably by suffocation from regurgitated food. Dog 9 was lost. Before the operation the animals, after the first one, received a hyper-

dermic injection of morphine. They were anaesthetized with ether. The skin about the knee was shaved, cleansed with soap and water, mercuric bichloride 1-1000, and alcohol. The wound was sutured in layers, usually with catgut. A plaster of Paris dressing was finally applied.

In many of the operations a piece of bone was implanted in the muscles of the thigh. The results of this bone implantation will be reported at another time.

After death the joint was examined in gross; then an antero-posterior section was made through it. The material was fixed in alcohol, or Orth's fluid, decalcified, usually in 5% nitric acid, run up through the alcohols, imbedded in celloidin, and stained with haematoxylin and eosin and by the van Gieson stain.

Dog 2, 2 years.

Nov. 10, 1913. Resection of right knee-joint.

Operation.—Incision curved, convexity downward, through the *ligamentum patellae*. The flaps were reflected and the joint was opened. The articular surface of the condyles was removed, and about one-eighth inch of the articular extremity of the tibia,—that is, a very small piece from each bone. Chromic sutures for the ligamentum patellae and capsule. Silk sutures for the integument. Dressing, gauze pads. Limb enveloped with absorbent cotton and bandaged. Plaster spica applied.

Dec. 20. Abdomen large. It is evident that the bitch is pregnant. Plaster removed therefore. Wound healed. Considerable motion is present between the fragments.

Jan. 4, 1914. Gave birth to five puppies.

Jan. 22. In good condition. Bitch has fairly good use of operated leg, though she favors it.

Mar. 18. Uses leg well. Fairly good motion antero-posteriorly.

July 9. Uses leg well. About 20° of motion.

Sept. 16. Uses leg well. About 20° of motion.

Nov. 20. Uses leg well. About 15° of motion. No lateral mobility.

May 4/15. Little if any motion.

Nov. 11. Dog uses limb fairly well. The operated joint seems larger than the other, and possesses a few degrees of motion. It is in about the normal attitude. Killed by gas.

Autopsy.—Joint has about 25° motion. Joint removed.

Sagittal section made with a saw. Bones are bound together by fibrous tissue (with a small joint cavity), and in this fibrous tissue there

are transverse clefts, one anteriorly and the other posteriorly. The convex lower end of the femur is received snugly into the concave upper end of the tibia, and motion in flexion is limited by the impinging of the femur against the posterior projection on the tibia, and extension is limited by the tight posterior ligament. The ends of the bones are somewhat sclerosed. A new articular surface for the patella has formed on the anterior surface of the femur. This is soft but smooth, and has the appearance of fibrous tissue. An incision on the lateral aspect of the joint shows that the thickening here is due to a pad of tissue which appears to be fibro-cartilage. Specimen into 80% alcohol.

HISTOLOGY.—A joint is present between the two bones. Each bone has at its end a small bare area, near the anterior portion of the joint. The rest of their extremities is covered by fibrous tissue and by fibro-cartilage. These tissues have cartilage at most of their surface. Long fingers or villi of cartilage protrude into the joint. The end of each bone is hollowed out to a limited extent and the excavation is filled by fibrous tissue. The cartilage on the anterior aspect of the lower end of the femur is fairly well preserved, but its surface is villous and irregular. It articulates with the patellar tendon, and the joint surface of this tendon is lined by villous cartilage, evidently the result of a change of the synovial membrane into cartilage. The tissue preserves the outlines of a villous synovial membrane, and is continuous above with synovial membrane, but it contains many cartilage cells in a delicate fibrous matrix, and has not the internal structure of a synovial membrane.

The cartilage of the patella is becoming delicately fibrillated at its surface. Its distal portion is replaced entirely by fibrous tissue, and this fibrous tissue is continuous at its lower portion with distinct synovial membrane. In other words, the synovial membrane is substituting the cartilage,—the exact opposite of what is transpiring in the patellar tendon, where the femur articulates with it. At one place on the anterior aspect of the femur, blood-vessels are pushing up through the buttress of bone, and the overlying cartilage is becoming fibrous in its whole thickness. Fibrous tissue is replacing the more superficial half of the proximal portion of the femoral cartilage, whose surface has the appearance of a synovial membrane.

The hollow in the end of each bone is, as said above, filled with fibrous tissue; and that in the tibia contains, in its part next the bone, fragments of bone trabeculae undergoing absorption. Evidently the bone has been hollowed out, and the hollow filled by fibrous tissue. Cartilage cells are seen in the fibrous tissue. The cartilage between the two

bones, like that on the posterior surface of the patellar tendon, has the internal structure of cartilage, but the outline of a villous synovial membrane.

The marrow of both bones is mostly fatty, with fibrous marrow at the extreme end. The bone trabeculae are thickened. The marrow of the patella is fatty.

SUMMARY.—Removal of small pieces of bone. Plaster of Paris for 40 days. Duration of experiment, 2 years.

Result.—Bones bound together posteriorly by fibrous tissue. The joint persists anteriorly. The ends of the bones are partly bare, but are mostly covered by cartilage, which was evidently produced from synovial membrane. The joint has a range of motion of about 25° (compare with joint 7).

Dog 3, Lost.

Dog 4, 122 days.

Nov. 14/13. Resection of right knee-joint. Preparation for operation as usual.

OPERATION.—Resection of right knee, removing only small portions of bone, as for dog 2. Wound sutured in layers with catgut. Plaster of Paris spica applied.

Dec. 2. Animal has gnawed the plaster about the ankle; as a result the dressing is looser, and the limb has considerable movement inside of it.

Dec. 6. The plaster has slipped back, and must be retained by a bandage.

Jan. 22/14. Plaster removed. Wound healed. Rather free motion between the bones.

Apr. 16. Dog has been ailing for past 48 hours, is very weak, has cough, nasal discharge and conjunctivitis. Uses leg fairly well in walking, though rather stiffly. About 30° of motion is present in the joint. Animal chloroformed. There appears to be some bone production about the joint, but there is no ankylosis—simply a restricted motion. Joint removed and put into Orth's fluid; later into alcohol.

Aug. 6. Sagittal section (anterior-posterior) of joint made with hack-saw. The ends of the bones are compact and are tightly united by fibrous tissue; but anteriorly and posteriorly there is a transverse slit in the fibrous tissue. A tongue of fibrous tissue appears to have extended up into the femur. The fibrous tissue appears continuous with the periosteum. The synovial cavity beneath the patella is preserved.

A section of the joint was made about 3/16 inch thick. On the other side of the section, that is, 3-16 of an inch away from the area just described, the tongue of fibrous tissue in the femur has disappeared, and the femur appears larger antero-posteriorly.

HISTOLOGY.—The irregularly convex end of the femur is received into the concave end of the tibia, and the ends of the bones are united by fibrous tissue, in which are clefts.

The trabeculae in the ends of both bones are thickened.

The concavity on the upper end of the tibia seems to be the result chiefly of a rarefying osteitis which has consumed most of the bone

A, Fibrous tissue over roughened patellar cartilage. *B*, Patella. *C*, Sesamoid bone. *D*, Fibrous tissue and fibro-cartilage.

trabeculae in the center of the head of the bone. A few trabeculae here show typical Howship's lacunae. The bone and marrow here are replaced by fibrous tissue, and this fibrous tissue extends down among the trabeculae of the bone beneath. The concavity is made deeper by a large projection of new-formed bone anteriorly, and by a smaller one posteriorly. In the marrow of the posterior process (lymphoid in character), and in the fibrous tissue just posterior to the anterior process, are islands of cartilage.

Posterior to the lower end of the femur, and connected with it by fibrous tissue, is a small piece of bone. It is surrounded by fibrous tissue, and contains a small island of cartilage at its extreme posterior part. It is probably a sesamoid bone. Apparently osseomucin is being deposited in the fibrous tissue about the bone island. The cartilage on the anterior surface of the femur is still present, but is overlaid by fibrous tissue, and its surface is irregular in places. It faces the fibrous tissue of the patellar tendon. A slit is present between these two, and the tissue at their surface has the appearance of a synovial membrane. The patella probably has been displaced upward by the operation, and articulates with the periosteum-covered femur. Its cartilage is still present, though its surface is irregular, and it is being replaced in its superficial portion by fibrous tissue.

SUMMARY.—Removal of small pieces of each bone. Immobilization, not very thorough, for 69 days. Duration of experiment, 122 days.

This appears to be a case of the formation of a new joint by the tying of the bone ends together by fibrous tissue. Clefts have formed in the fibrous tissue. The end of the tibia has been hollowed out to receive the convex end of the femur. This hollow has been deepened by the production of new bone, anteriorly and posteriorly, on the tibia.

Dog 5, 21 months.

Nov. 17/13. Resection of right knee-joint.

OPERATION.—Incision curved, convexity downward, running below patella. Flap retracted, joint opened. Tips of condyles removed and about one-eighth inch from head of the tibia,—that is, very little bone. Deep chromicized catgut and superficial silk sutures. Plaster spica.

Nov. 19. Spica has slipped; removed; new spica. Wound in good condition.

Nov. 20. During night the spica slipped off entirely. In spite of this fact the dog does not appear to suffer and the wound is not injured. New spica.

Nov. 23. Spica came off; renewed. Swelling better. Wound looks good.

Nov. 28. During night the spica came off. Wound is completely closed by first intention. All swelling has disappeared. Leg in excellent condition.

Dec. 1. New plaster dressing, running up around neck.

Dec. 6. The spica has a tendency to slip backward. Held in place by applying bandage about neck.

Jan. 22/14. Dog in excellent condition. Plaster broken; removed. Bones evidently united fairly firmly with fibrous tissue. Some motion is present between them. The dog can use the leg for bearing weight.

Nov. 20. Uses leg a little. About 10° or 15° of motion; no lateral motion.

May 4/15. Apparently firm ankylosis.

Aug. 13. Dog uses the leg well. Killed by illuminating gas. Joint removed. There are about 5° to 10° of motion in it. No lateral motion.

A, Fibro-cartilage. *B*, Intra-articular ligament. *C*, Patella. *D*, Articular cartilage. *E*, Fibrous tissue. *F*, Synovial membrane.

Patella freely movable. Sagittal section into alcohol. There is no evidence of union between the bones, except by a fibrous cord midway of the joint. Anterior and posterior to this are joint cavities. The obstruction to flexion and extension is caused by the tightness of this band and by the flattening off of the contiguous surfaces of the femur and tibia. They fit very tightly together.

HISTOLOGY.—The microscopic findings confirm the macroscopic. The two bones are held tightly together by an intra-articular ligament, and their opposing surfaces, covered by fibro-cartilage and fibrous tissue, are practically plane surfaces. In places the surface is covered by a film of

degenerated tissue. The cartilage cells are found mostly close to the bone. A well developed joint cavity, divided by the intra-articular ligament into two compartments, is present. The anterior pouch is continuous with that on the anterior surface of the lower end of the femur. Posterior to the posterior slit the bones are bound together by fibrous tissue and fibro-cartilage. A synovial membrane with well marked villi covers the periosteum on the anterior surface of the lower end of the femur, but does not extend in between the tibia and femur. The cartilage on the posterior surface of the patella is covered by fibrous tissue, possessing also a synovial lining in places. The cartilage has been replaced at the periphery and at the center by fibrous tissue. The bone of the patella stains poorly, and is degenerating. The marrow is fatty. The bone trabeculae in the extreme ends of the femur and tibia are quite thick, and stain well. The marrow here is fatty. Farther away from the joint the trabeculae stain poorly, and seem to be undergoing absorption.

SUMMARY.—Removal of small pieces of bone. Immobilization for over 2 months. In this specimen, after 21 months, we find a process which, as far as the joint itself is concerned, apparently has run its course. The head of each bone is covered by fibro-cartilage, and a well-marked joint is present. No adhesions have formed between the bone ends. No ankylosis is present. The limitation of motion is due simply to the tight apposition of the flattened and broadened bone ends. The bone is dense in the end of the tibia and of the femur, and is disappearing in the patella.

Dog 6, 462 days.

Nov. 19/13. Resection of right knee. Operation as in previous cases, removing a rather small amount of bone. Plaster spica.

Nov. 22. Spica entirely off the body and badly gnawed on the leg. Later the animal had completely torn the spica and dressings off the wound. New spica applied. At one point the skin margins of wound are separated for about one-half inch. Slight discharge, reddish and slightly purulent.

Nov. 23. Spica gnawed off. Slight discharge from wound. Wound to be left uncovered so that animal may lick it. The knee is in flexion.

Nov. 26. Wound gaping a little at middle; no swelling, very little discharge; condition satisfactory.

Dec. 1. Skin-wound about same. Considerable serous fluid from the wound. Knee region slightly swollen.

Jan. 22/14. Wound healed a couple of weeks ago. Animal in good condition, but will not use operated leg.

Mar. 18. Animal uses leg. Some motion between bones.

July 9. A useful, movable joint of good stability is present.

Sept. 16. Good range of motion. Useful, painless joint.

Feb. 24/15. Animal in health, uses leg well. Wound is healed. Killed by blow on back of head and ether. Knee in semiflexion. Range of motion between about 115° and 65°,—that is, 50°.

Feb. 24. Joint removed and sawed sagittally. No bony union. Fibrous union between femur and tibia. Upper end of tibia cupped. In mass of fibrous tissue there are one or two small cavities. A joint is present between patella and condyles. Ends of bones seem to be quite dense; condyles fit into a slight concavity in the upper end of the tibia.

HISTOLOGY.—The bones are tied together by dense fibrous tissue, in which are two or three small clefts. The femoro-patellar joint is in good condition, except that the synovia is encroaching on the patellar cartilage from the side, and is somewhat villous and thickened, and in one place fibrous tissue is pushing up through the cartilage of the femur (Type I), at the surface to meet the synovial membrane, extending in from the side.

The cartilage on the posterior portion of the femur, spared by the saw, is, except for some irregularity of structure and some surface degeneration, fairly normal; but as it approaches the fibrous tissue binding together the two bones (femur and tibia) it becomes fibrillated. Under the fibrous tissue on the end of the femur runs a buttress of bone, pierced by small channels containing blood-vessels.

The fibrous tissue over the end of the tibia contains many groups of cartilage cells. The buttress of bone is not as well marked as on the femur, and in one area about 5 mm. in diameter does not exist. The fibrous tissue here seems to be pushing down into the head of the tibia, and so forming a cavity in it.

The marrow in both bones is fatty, with a little lymphoid. Synovial membrane is seen anteriorly and posteriorly, but there is none in the uniting fibrous tissue.

SUMMARY.—Removal of rather small amount of bone. Ineffectual immobilization for a few days. Duration of experiment, 462 days.

Result.—The bones are bound loosely together by fibrous tissue, in which no synovial cavities are seen. The process seems to be practically at an end, without prospect of any firmer union than at present exists.

Dog 7, 23 months.

Nov. 21/13. Resection of right knee-joint.

Operation as in previous cases. Greatest thickness of piece of condyles removed, 7 mm.; greatest thickness of articular end of tibia resected, 5 mm.—small pieces. Deep chromicized and superficial plain catgut sutures. Plaster spica applied.

Feb. 27/14. Galled by plaster. Plaster removed. Good firm union of bones; no apparent motion with use of moderate force.

A, Fibro-cartilage in tibia. *B*, Bare bone. *C*, Fibro-cartilage in femur. *D*, Articular cartilage. *E*, Synovial pocket. *F*, Fibrous tissue over patellar cartilage. *G*, Patellar cartilage. *H*, Patella. *I*, Synovial membrane.

Mar. 18. Uses leg. Very little motion.

Nov. 20. Very little motion, no lateral motion.

May 4/15. Very stiff. Apparently firm ankylosis.

Oct. 4. In health. Animal killed by illuminating gas. The knee possesses about 20° motion in flexion and extension. No lateral motion possible.

Joint excised and sawed sagittally.

No adhesions between bone ends are present, no attempt at bony union. A well marked joint cavity is present between the two bones, and the only obstruction to motion is by the capsular ligaments. The femur is convex, rounded off, smooth, cartilage-like, and fits into concavity in the tibia, which is also smooth and cartilage-like.

Ends of bones appear denser than normal.

HISTOLOGY.—A distinct joint is present between the two bones, and their ends evidently have been so remodeled that they fit well to each other. The lower end of the femur in gross is smoothly convex, and the upper end of the tibia is concave. The tibia seems bigger antero-posteriorly than normal.

The ends of the bones are seen to be bare over a small portion of their extent. The bare bone of the tibia is very rough, of the femur rather smooth. Over the rest of their articular ends they are covered by fibrous tissue, which in turn is overlaid by a layer of rough, shaggy, villous fibro-cartilage. The cartilage on the anterior aspect of the lower end of the femur is preserved, and in good condition, except that it is becoming fibrillated at its surface. From its surface also spring more finger-like processes, one of them very long. This cartilage on the anterior aspect of the femur articulates with the fibrous tissue of the patellar tendon and with the patella, which is mostly covered by synovial membrane. Clefts in the fibrous tissue are lined also with synovial membrane.

The patellar articular cartilage is present. The surface, irregular in places, is overlaid by fibrous tissue, to which it is tightly adherent over a portion of its extent. The exact limit of the two cannot always be defined. At the surface of the fibrous tissue, where it articulates with the cartilage of the femur, is a small patch of synovial tissue, and another one at the extreme proximal end of the crural pouch.

Immediately beneath the bare area at the end of each bone, in the marrow, is a small area of fibrous tissue containing cartilage cells. The marrow in each bone is mostly fatty. There is no sign of active bone production. The process apparently is finished.

SUMMARY.—Removal of small pieces of bone. Immobilization for 98 days. Duration of experiment, 23 months.

Result.—Formation of new joint. The bone ends are lined for most of their extent by fibro-cartilage. Presumably, from the villous appearance of the fibro-cartilage, it has been produced by a spreading in of the synovial membrane. Remnants of a synovial membrane persist in the capsule. Activity in the reparative process apparently is ended.

Dog 8, 432 days.

Dec. 1/13. Usual preparation. Resection of right knee. Removal of 9.5 mm. of tuberosities of tibia and 16.5 of lower end of femur. *Removal of patella and its burial in gluteal muscles.* Deep sutures of chromicized catgut, and superficial sutures of silk. Catgut and silk in wound in gluteal muscle. Plaster of Paris spica applied.

Jan. 22/14. Plaster filthy. Pressure sores. Plaster removed. Rather firm union, with large bony callus. Very little motion present.

Mar. 18. Animal doing well. She uses leg. Firm union present.

July 9. No motion at site of operation.

Feb. 13/15. Dog killed by ether anaesthesia. Very little movement in joint. Wound healed. Joint removed; sawed sagittally and placed in 80% alcohol.

Feb. 19. Sagittal section of knee shows firm bony union of femur and tibia. The bone in the vicinity seems denser than normal, and there is a well marked tendency to the formation of two strips of dense bone prolonging the cortical bone above and below. The marrow is yellow except in a few small patches, where it is red.

HISTOLOGY.—The bones are united by bone, and this bony union does not extend clear across the specimen but across only about its central third. On one side of the slide extending in from the anterior aspect is a plug of fibrous tissue and fibro-cartilage, binding together the ends of the bones. On the other side is another plug of fibrous tissue and fibro-cartilage streaming in from the posterior aspect, and tying the ends of the bones together. In places where the uniting tissue joins the bone, especially in the posterior plug, a layer of cartilage is present, which is undergoing ossification. The bony union is represented by rather dense bone, continuous with trabeculae above and below,—that is, in the femur and tibia. Here and there in the band of dense bone are groups of cartilage cells, whose capsules are frayed and indistinct. At the anterior extremity of the posterior plug, a bundle of fibrous tissue runs from it into the marrow. There is no sign of bone condensation at the cortex. The marrow is mostly fatty. Here and there small areas of lymphoid marrow are seen. Many giant cells are seen in the area of bony union, especially that part of it composed of cartilage. There are a few also at the anterior extremity of the posterior plug of fibro-cartilage.

Many of the marrow spaces contain quantities of bone detritus, bits of necrotic bone, some of which can be seen connecting with the trabeculae; that is, the trabeculae seem to be breaking up into fragments, but not by any action of fibrous tissue or of osteoclasts.

SUMMARY.—Removal of rather large pieces of bone. Immobilization for 54 days. Duration of experiment, 432 days.

Result.—Bony union between a portion of the bones; fibro-cartilaginous union, evidently becoming bony, between the rest.

Dog 9, 98 days.

Dec. 15/13. Usual preparation. Resection of right knee. Removal of 20.5 mm. of femur, 14 mm. of tibia (a very large amount). Deep sutures of chromicized catgut, superficial sutures of silk. Plaster of Paris spica applied.

Dec. 27. Plaster has been chewed up so as to be of no use. Remnants removed. Wound healed per primam. Bones freely movable. Silk removed. New plaster spica applied.

Dec. 29. Plaster chewed off again. Removed.

Jan. 22/14. Animal uses operated leg somewhat, though favoring it.

Mar. 18. Free motion.

Mar. 23. Chloroformed. No sign of any infection. Wound healed and hair grown over it. The joint possesses a range of motion of about 90° and is fairly firm when extended. In flexion it is wobbly. Joint removed.

Apr. 24. Bones removed from acid. The soft parts have been detached so that the bones fell apart. Section cut from tibia and femur for further decalcification. Material lost.

Dog 10, 208 days.

Dec. 15/13. Small bitch. Usual preparation. Resection of right knee, removing 20 mm. from femur, 11.5 from tibia (large pieces for this sized dog). Suture as usual; plaster spica.

Jan. 22/14. Plaster removed; it was of very little use. There appears to be a production of callus on the lower end of the femur, but the tibia is very loose and wobbly. What union there may be is very unstable. Stitches removed. Wound healed.

Mar. 18. Animal uses leg a little. The operated joint is quite wobbly.

July 9. Genu recurvatum. Freely movable, laterally and anteroposteriorly.

July 11. Dog died suddenly this morning.

AUTOPSY.—Lungs engorged. Pneumonia in stage of red hepatization—rather extensive. Joint removed.

Aug. 6. Femur seems displaced somewhat laterally. Joint sawn sagittally. The ends of the bones are apparently denser than normal, and are bound together by fibrous tissue, in which there are two partial transverse slits, like partial joints. The synovial cavity under the patella has disappeared except at its distal part, where one of the slits is. The cartilage is present anteriorly over the femur.

Histology.—The ends of the bones are tied loosely together by fibrous tissue, in which are many clefts, some lined by a synovial membrane. On the anterior aspect of the lower end of the femur is a large knob, and another on the posterior. These knobs are composed of bone, fibro-cartilage and fibrous tissue. Vessels are pushing into the fibrous tissue and the fibro-cartilage from the marrow beneath, and are converting them into bone. Many thick trabeculae have been formed in the end of the femur, and the end of the bone is covered by fibrous tissue, with a synovial surface shutting off communication between joint and marrow. A depression exists between the two knobs on the end of the bone, and lying in this depression are masses of connective tissue—villi—for the most part covered by a synovial membrane, and smaller masses of hyaline fibrous tissue in which are many cartilage cells, single and in irregular groups. The marrow of the femur is a mixture of lymphoid, and fatty.

The head of the tibia has been subluxated backward, and articulates with the knob on the posterior aspect of the femur, to which it is tied by fibrous tissue. On account of a lateral displacement of the two bones, the head of the tibia appears in the slide only as a thin piece of bone. The trabeculae in the patella are scant, and take the eosin stain very poorly. They are evidently being consumed. The marrow is largely fatty. Fibrous tissue has grown in over the cartilage at its proximal portion, obliterating the joint in this region. The joint is also largely filled by fibrous tissue. The surface of the patellar cartilage is rough, and in one place in the section a communication exists between the marrow and the fibrous tissue covering the cartilage. The limits of the encroaching fibrous tissue and those of the cartilage cannot be exactly defined.

Summary.—Removal of large pieces of bone. Ineffectual immobilization for 5 weeks. Duration of experiment, 208 days. A joint exists in this case, without any tendency to obliteration. The fibrous union is a loose one. The lower end of the femur forms the cup (the only instance in our series), by means of the production of new bone and cartilage. It is covered by fibrous tissue, with a synovial lining. A

synovial covering also is present on the fibrous villi in the joint, and some of these villi are transforming into cartilage.

Dog 12, 14 days.

Rather small young bitch.

Jan. 28/14. Resection of right knee. Removal from femur of 22.5 mm., from tibia of 8.5 mm. Patella into gluteal muscles. Wound suture same as in preceding experiments. Plaster spica applied.

Feb. 4. Plaster galls; removed. Ugly sore under opposite thigh.

Feb. 5. Operation wound healed.

Feb. 11. Dog has been ailing for 48 hours. Now looks worse.

Feb. 12. Dog died last night. Blood-streaked saliva before death.

AUTOPSY.—The operation wound is almost healed, and shows no sign of infection. There is no fluid in the joint, which is movable in flexion and extension. Joint not opened, put into Orth's fluid.

The abdominal cavity was full of a haemorrhagic exudate, and multiple haemorrhages were found in peritoneum. The lungs were the seat of multiple haemorrhages also. The liver was reddened and seemed roughened.

Feb. 23. Material put into 10% nitric acid solution.

Mar. 25. Joint cut sagittally with a knife. The bones are rather firmly united by fibrous tissue at their circumference. The head of the femur is subluxated laterally on the tibia. The ends of the bones are covered by loose fibrous tissue, but are not united. No adhesions are present. A piece of cartilage can be seen on the posterior portion of the head of the tibia. Two sagittal sections made, and put back into 10% HNO_3.

HISTOLOGY.—A joint cavity is plainly seen between the two bones. The end of the femur is covered by fibrin, the end of the tibia partly so. Fibrin lines also the soft parts of the joint, and beneath it is fibrous tissue with very fine collagen fibrils. Nothing that looks like synovial membrane can be seen.

Femur.—The bone ends are very straight, as cut by the saw. A few remnants of necrotic cartilage lie beneath the fibrin. The marrow is packed with cells, and near the joint is undergoing fibrosis. Here, near the joint, the trabeculae are extremely irregular in their arrangement, and in their staining. Either they are undergoing necrosis, or bone production through the medium of fibrous tissue is taking place. Rarefying osteitis is going on at the side of the bone near the line of section, with osteoclasts in Howship's lacunae. One side of the cortex

(that on the side opposite to the rarefying area) presents a peculiar appearance. A layer of dense bone, which we take for the original cortex, is overlaid by a layer of spongy bone with the staining qualities noticed in some of the trabeculae in the bone end. This layer of spongy bone, when followed toward the joint, contains near the line of section large irregular areas of cartilage which appear to be ossifying. Communications exist between the marrow of the spongy and the dense areas. The marrow in the former is fibrous and oedematous, in the latter lymphoid. We regard the spongy layer as new periosteal bone.

Tibia.—The joint end is lined in places by fibrin, in places by necrotic material. The tissue beneath the former is fibrous, beneath the latter, bone. The trabeculae near the joint are numerous and are irregular in their staining reaction. They are evidently degenerating.

SUMMARY.—Removal of large pieces of bone. Immobilization for one week. Duration of experiment, 14 days.

Result.—Free motion between the bones, and a cavity between them lined by fibrin. Beginning periosteal bone formation to remodel the end of the femur.

Dog 13, 88 days.

Jan. 29/14. Resection of right knee. Removal of 20 mm. from femur and 12.5 mm. from tibia. Patella buried in glutei. Suture as usual. Plaster spica applied.

Feb. 28. Plaster removed.

Mar. 18. Apparently firm union.

Apr. 27. Dog died last night of an epizootic that has affected most of the dogs.

AUTOPSY.—Apparently firm bony ankylosis, with production of new bone. The lungs are consolidated and hyperaemic through much of their extent. Adhesions in the left pleura are present. *Pneumonia.* Joint removed in toto, with about 3 cm. of bone on each side. No sign is present of any infection whatever. Apparently complete firm ankylosis. Red marrow in the shaft of both bones. (At line of section there was the beginning of a central canal.)

Aug. 10. Joint sawn sagitally. The bones are tightly united, giving the impression of bony union, but a fine line of division can be made out. The bones are very dense in structure, but at two or three places there are areas of soft tissue, near the joint line.

Dec. 15/15. Review of specimen. The blocked section shows a fine line of cartilage running across between the two bones, but one side of the joint left in alcohol shows an actual bony union between the two.

HISTOLOGY.—On the anterior aspect of the lower end of the femur is a layer of cartilage, which extends in between the femur and tibia, and unites the bones firmly for about half the line of their junction. At the posterior extremity of this thin band of cartilage is a small area where the trabeculae pass from one bone to the other (bony union). Vessels are pushing into the cartilage from both bones, and the cartilage is undergoing ossification. Posterior to this bony band of union, the tibia

A, Dense fibrous tissue. *B*, Fibro-cartilage. *C*, Cartilage.

and femur are united by dense fibrous tissue. Posterior to this, the uniting tissue is composed of fibrous tissue and fibro-cartilage. At the posterior part of the line of junction are two fairly large areas of hyaline cartilage separated by a layer of fibro-cartilage. These are immediately beneath the posterior ligament. Ossification of these areas of cartilage is going on from above and below. In the middle of the area next the femur are several capillaries, giving an appearance identical with that seen in the early stages of ossification in the epiphysis,—by tufts of blood-vessels pushing in from the marrow beneath and starting an ossific center in the cartilage. This same phenomenon is present in the cartilage on the anterior aspect of the femur.

The bone trabeculae in both bones are irregular in their arrangement, and extremely so in their staining. Their cells also stain very poorly or not at all. Many of the trabeculae near the line of junction are composed largely of cartilage ossifying at its margin. Islands of cartilage can also be seen in the marrow. The marrow is largely lymphoid, but near the line of junction it is mostly fibrous. Areas of a hyaline substance are abundant in the marrow. So-called osteoclasts in Howship's lacunae can be seen here and there.

SUMMARY.—Removal of large pieces of bone. Immobilization for 30 days. Duration of experiment, 88 days.

Result.—Bony union, through the medium of fibrous tissue and cartilage.

Dog 14, 117 days.

Feb. 3/14. Resection of right knee. Removal of 20.75 mm. from femur and 9.5 mm. from tibia. Patella into glutei. Usual suturing. Plaster spica applied.

Feb. 21. On account of excoriation, plaster removed. Wound healed except at its outer end, where it is granulating.

Mar. 18. Doing well. Uses leg a little. Free motion.

June 1. Animal died yesterday; she had been ailing for a couple of days.

AUTOPSY.—The incision has healed completely. The knee is freely movable. Cause of death not discovered. The lungs seem very dry. Knee and patella removed and put into 80% alcohol.

Aug. 8. Joint sawn sagittally. The end of the femur is received into a cup-shaped surface of the tibia. Both bones seem eburnated. There is a well defined joint cavity, and no fibrous connection between the cut surface of the bones, but some loose fibrous tissue on these surfaces.

HISTOLOGY.—A joint is present between the two bones. The trabeculae in the end of the femur are much thickened, and are arranged irregularly. The marrow near the joint is fibrous, at a little greater distance it is lymphoid, and the trabeculae are more sparse. The trabeculae in the head of the tibia are increased in number and thickness.

The ends of both bones are rough, and are partly covered by fibrous tissue. Synovial membrane covers part of this fibrous tissue. Especially over the head of the tibia the extension inward is marked. No articular cartilage is present. A synovial membrane, thickened and villous, lines the capsule. Much of the synovial membrane is covered by a material which looks like fibrin. In a fibrous plug going down into the head of

the tibia are a few cartilage cells. In some of the villi also groups of cartilage cells are seen.

SUMMARY.—Removal of a large amount of bone. Immobilization for 18 days. Duration of experiment, 117 days.

Result.—Formation of a new joint, but without the formation of a new articular cartilage. Synovial membrane lines the capsule.

Dog 15, 240 days.

Feb. 5/14. Resection of right knee. Removal of 21 mm. from femur, 7.75 from tibia. Patella buried in glutei muscles. Usual suturing and plaster spica.

Mar. 19. Plaster filthy; removed. Considerable motion is present.

July 9. Free motion.

Sept. 16. Moderate amount of motion.

Oct. 1. Killed with ether. The joint possesses free motion in arc of 90° and moves smoothly.

Oct. 3. Sagittal section through joint. There is a small joint cavity divided into compartments by fibrous tissue on the lateral and medial aspect of the former joint; but throughout the middle portion of the union and including the section saved, no cavity can be seen and the bones are united by dense fibrous tissue. Bone ends are dense, and marrow is present in the shaft of the tibia and femur. The end of each bone is concave.

HISTOLOGY.—The bones are bound loosely together by a thick band of dense fibrous tissue in bundles, with rifts and spaces in it. Some of the spaces contain detritus, others are lined by synovial membrane, with a marked villous proliferation. The fibrous bundles run in all directions, some directly between the two bones, others in from the periosteum to the end of either bone, where they merge into the bony tissue itself, and pass also into the marrow spaces. The upper end of the tibia is hollowed out, although the femur does not fit into it, and the fibrous tissue fills most of the space between the two layers of cortical bone. There is little bone here in the hollowed-out area, but farther away from the joint thick trabeculae abound (shutting off the marrow canal from the end of the bone). From these thick trabeculae slender trabeculae run toward the joint, in the fibrous tissue. Apparently they are being replaced by fibrous tissue. Here and there can be seen giant cells in Howship's lacunae.

The marrow is lymphoid, except for the fibrous marrow in the ends of both bones.

A large synovial cavity is present posterior to the line of junction of the bones, and another anterior to the lower end of the femur. The latter is probably the remains of the quadriceps pouch. A third fairly large cavity is present in the fibrous tissue between the two bones near the posterior portion.

SUMMARY.—Removal of large pieces of bone. Immobilization by plaster of Paris for 42 days. Duration of experiment, 240 days.

Result.—Loose fibrous ankylosis with persistence of synovial cavities, and no indication of the conversion of this ankylosis into bone.

Dog 16, 97 days.

Feb. 16/14. Resection of right knee. Removal of 20 mm. from the femur and 17 mm. from the tibia. Patella into glutei. Plaster spica applied.

Apr. 11. Plaster removed. It was foul about the site of operation, where the skin was red and granulating.

May 25. Dog has been sick for some time. He was stricken with paralysis two days ago, and died yesterday.

AUTOPSY.—Right lung pale. Contains what is probably an old organized pneumonia in two or three small areas. Embolus in left lung. Organized thrombus in heart.

Knee appears firmly ankylosed, with bony proliferation. Wound has completely healed. Sections from lung show pneumonia and organized emboli.

Aug. 10. Joint sawn sagittally. The ends of the bones are tightly united, in fact so tightly that in one place the union appears bony. The ends of the bones seem very dense.

HISTOLOGY.—The bones are bound together tightly by dense fibrous tissue in the middle of the section, without any rifts, and containing a few cartilage cells here and there. There is no suggestion of a joint cavity anywhere. The union is very firm. Anteriorly and posteriorly fibro-cartilage binds the bones together, and appears to be undergoing ossification where it meets the bones. Anteriorly the tibia is developing a spur of bone up in front of the femur, out of fibro-cartilage; that is, a mass of fibro-cartilage in front of the lower end of the femur is undergoing ossification from the bone in the tibia below. It is also being ossified from the femur posteriorly, and shows in its interior a typical picture of endochondral ossification, as in an epiphysis. This makes the union very firm. The bone trabeculae at the end of each bone are quite

abundant, and form a well marked transverse layer, more or less toothed. The uniting fibrous tissue merges into these teeth of bone. The marrow in the immediate vicinity of the operated area is fibrous and oedematous, in other situations it is lymphoid. A small wedge of fibrous cartilage is

A, Dense fibrous tissue. *B*, Fibro-cartilage. *C*, Bone. *D*, Cartilage.

present between the bones posteriorly, and is being ossified from the marrow of each bone. A small sesamoid bone behind the line of junction of the bones has been caught by the microtome.

SUMMARY.—Removal of large pieces of bone. Immobilization by plaster for about 8 weeks. Duration of experiment, 97 days.

Result.—Firm union by fibrous tissue and by fibro-cartilage. This fibrous tissue and fibro-cartilage are being converted into bone. The indications are that the union eventually would have been bony.

Dog 17, 347 days.

Feb. 28/14. Resection of right knee. Removal of 22 mm. from the femur (an enormous piece for a dog of this size, and almost reaching the medullary canal. A good layer of dense cortex is present at point of section), and 7 mm. from tibia. Patella buried in thigh muscles. Plaster spica applied.

Mar. 10. The plaster has been so badly gnawed that it is of no use; removed. Wound healed. Much motion at knee.

July 9. About 20° of motion.

Sept. 16. Very little motion.

Feb. 10/15. Uses leg fairly well. About 30° of motion in joint. Killed by chloroform. Line of incision over anterior aspect of joint seen. Knee-joint removed. Sectioned longitudinally.

The femur is received into an actual cavity of the tibia, a hollowing out of the upper surface of the tibia. There are indications of a joint in places, and the bones are united by fibrous tissue. The ends of the bones are eburnated, and are very dense. Sawing done with considerable difficulty.

HISTOLOGY.—The end of the femur is received into a cup-shaped cavity in the tibia, as above, and the ends of both bones are covered with cartilage and fibro-cartilage. There is a distinct slit between the bones anteriorly, and another posteriorly, but in the center the bones are joined by fibro-cartilage and cartilage. At the margin of the section the connecting tissue is fibrous. Several other irregularly transverse rifts are also present.

The posterior slit begins behind the posterior aspect of the lower end of the femur, between it and the tongue-like process on the tibia, passes obliquely downward and forward, and then turns and runs at right angles transversely about half-way across the joint. There is a tendency in some of the slides toward a shutting off of the lumen of this slit by strands of degenerated fibrous tissue and small tongues of cartilage where it changes its direction, but the two arms in other slides are seen to communicate. The longitudinal arm is lined by cartilage, with a homogeneous or delicately fibrous basement substance. The cartilage cells stain well, have distinct capsules, and are arranged in groups. In places the cells are not cartilage cells, but are typical fibroblasts. The surface of the cartilage is not regular, as is customary with joint cartilage, but has a contour like that of villous synovial membrane, with finger-like processes, which have been cut at various angles. In many places a film of degenerated cartilage lines the slits. There are one or two villi also which look like typical synovial villi, and contain a few cartilage cells. The layer of cartilage is irregular also in its thickness and in its structure, and is not backed up by a buttress of bone as is the normal joint cartilage, but by irregular bone trabeculae, containing fibrous tissue in their meshes. It is for the most part hard to tell where bone shades off

into cartilage. In other words, the deeper portion of the cartilage is undergoing transformation into bone.

The anterior slit, very irregular in outline, is lined by the peculiar degenerated fibrous tissue, containing very few cells. Many villi are

A, Spur on tibia. *B*, Cartilage capping the spur. *C*, New bone in femur. *D*, Cartilage capping this bone. *E*, New articular cartilage. *F*, "Bursal cavities." *G*, Synovial cavities. *H*, Sesamoid bone.

present, composed of fibrous tissue, with a few cartilage cells. In the extreme anterior portion of the specimen, anterior to the end of the femur, is a small typical synovial cavity.

A marked thickening has taken place in the trabeculae of both bones. The marrow in the immediate vicinity of the joint is fibrous, farther away it is lymphoid.

SUMMARY.—Removal of large amount of bone. Plaster of Paris for a few days only. Duration of experiment, 347 days. The convex end of the femur is received into a concavity of the tibia. The concavity is formed by anterior and posterior tongues of bone in the tibia. The bones are united by cartilage and by fibro-cartilage, and at the periphery by fibrous tissue. Slits of greater or less size are present in the cartilage and fibro-cartilage. These slits are lined by villous and irregular cartil-

Mar. 10. The plaster has been so badly gnawed that it is of no use; removed. Wound healed. Much motion at knee.

July 9. About 20° of motion.

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into cartilage. In other words, the deeper portion of the cartilage is undergoing transformation into bone.

The anterior slit, very irregular in outline, is lined by the peculiar degenerated fibrous tissue, containing very few cells. Many villi are

A, Spur on tibia. *B*, Cartilage capping the spur. *C*, New bone in femur. *D*, Cartilage capping this bone. *E*, New articular cartilage. *F*, "Bursal cavities." *G*, Synovial cavities. *H*, Sesamoid bone.

present, composed of fibrous tissue, with a few cartilage cells. In the extreme anterior portion of the specimen, anterior to the end of the femur, is a small typical synovial cavity.

A marked thickening has taken place in the trabeculae of both bones. The marrow in the immediate vicinity of the joint is fibrous, farther away it is lymphoid.

SUMMARY.—Removal of large amount of bone. Plaster of Paris for a few days only. Duration of experiment, 347 days. The convex end of the femur is received into a concavity of the tibia. The concavity is formed by anterior and posterior tongues of bone in the tibia. The bones are united by cartilage and by fibro-cartilage, and at the periphery by fibrous tissue. Slits of greater or less size are present in the cartilage and fibro-cartilage. These slits are lined by villous and irregular cartil-

age, some of it necrotic, and evidently produced from synovial membrane. Some evidences are present of the transformation of the deeper portion of the cartilage into bone. No ankylosis is present.

Dog 18, 317 days.

Mar. 9/14. Resection of right knee by mortise method, removing 20 mm. from femur and 15 mm. from tibia. Patella into glutei. Plaster spica applied.

Apr. 18. Plaster removed. Slight movement in joint.

July 9. Practically no motion.

Nov. 20. Very stiff. Uses leg very clumsily.

Jan. 20/15. Well nourished, healthy animal, killed by blow on head. Used leg well, but knee-joint is ankylosed. Joint removed and sawed sagittally. Apparently bony union in places.

HISTOLOGY.—The convex lower end of the femur is firmly united to the concave upper end of the tibia by a thick layer of fibrous tissue, fibro-cartilage and cartilage. In this tissue are small transverse clefts. The fibers of the fibrous tissue and of the fibro-cartilage run generally transversely near the joint circumference, but in the center they run from bone to bone. The tibia and femur are not united anywhere by bone, but in certain areas the fibro-cartilage is undergoing ossification by blood-vessels extending from the marrow of each bone. The uniting tissue is continuous with the tissue in the marrow spaces, and also attaches firmly to the bony trabeculae. The bone trabeculae are thickened. The marrow is mostly lymphoid.

The posterior cortex of the femur spreads out as it nears the joint. The trabeculae springing from it are arranged in fan-shape, as are those springing normally from the medial cortex of the femur, and running up to the femoral head. These trabeculae and the cortex support the weight of the body, and are arranged generally in a distinct longitudinal direction. Anterior to them in the specimen, this regular arrangement is absent. The marrow here is full of fragments of dead bone, evidently being destroyed by the marrow, but no sign of "osteoclasis" (giant cells and Howship's lacunae) is present.

SUMMARY.—From this operation, done with a special endeavor, by mortising the bones, to secure close apposition and no motion, and thus to attain a firm ankylosis, fibrous and fibro-cartilaginous union is present after 317 days. A few transverse slits persist in the fibrous tissue, but these have no synovial membrane. The limb had been immobilized with plaster of Paris for 40 days.

Dog 19, 40 days.

Mar. 12/14. Resection of right knee, removing 27.5 mm. from femur, 14.5 from tibia. The periosteum was united carefully by deep stitches, holding the bones rather firmer than usual. Patella into glutei. Plaster spica applied.

Apr. 21. Plaster removed.

Apr. 22. Animal died during the night.

AUTOPSY.—Knee freely movable. Excellent joint. Patella and knee removed, and placed in alcohol.

Aug. 11. Bones sawn sagittally. A well defined joint-like slit is present between their ends, lined with what appears to be delicate new connective issue. No eburnation or sclerosing of the bone ends is present. On the lateral aspects of the ends of the bones cartilage is present, but not in the section removed for study. The tibia is subluxated backward on the femur, and apparently a large production of new fibrous tissue has occurred behind the lower end of the femur.

HISTOLOGY.—The tibia and femur articulate at an angle of about 130°, and a joint cavity is present between them. The tibia is subluxated backward on the femur, and the architecture of its articular extremity is being re-formed in the following manner:

Anteriorly a large projection or shelf has been formed which juts out at right angles with the shaft. (In the lateral portions of the specimen, which have not been cut for sections, this shelf consists of cartilage.) This shelf is composed of bone and cartilage, the cartilage toward the joint. At the junction of the bone with the cartilage, blood-vessels may be seen pushing up from the marrow of the former into the latter, and the picture is typical of endochondral ossification. The cartilage is new, and not the remains of any articular cartilage, and is separated from the joint by a thick mass of fibrous tissue, covered near the circumference by a synovial membrane, and villous nearer the middle, but without the peculiar cells of a synovia at the surface.

Posteriorly between the two bones,—that is, in their re-entrant angle, between the posterior surface of the head of the tibia and the posterior cortex of the lower portion of the femur,—is another large mass of cartilage. This cartilage is united to the head of the tibia by dense bands of fibrous tissue, in which, close to the tibia, are some bony trabeculae, with Howship's lacunae. Among these bands are ramifications of the joint cavity or separate joint cavities. These are lined by synovial membrane. The cartilage is united to the cortical bone on the

posterior surface of the lower portion of the femur, partly by fibrous tissue, and partly by spongy bone springing from the cortex. The cartilage where it impinges on the femur is undergoing ossification—typical endochondral bone formation—and blood-vessels can be seen in it, giving an identical picture with that seen in beginning ossification of an epi-

A, Spur on tibia. *B*, Cartilage over spur, being ossified from the bone marrow beneath. *C*, Cartilage posterior to lower end of femur. *D*, New spongy bone on femur. *E*, Pockets lined by synovial membrane.

physis. The lowermost part of the cortex is being rearranged in its architecture to open up a communication between the spongy bone within and that without. In other words, ossification of the first mass of cartilage described is taking place from the tibia; of the second mass, mostly from the femur.

The ends of both bones are covered by fibrous itssue, having prolongations running down into the marrow. No articular cartilage is present anywhere. The joint is lined in places, especially near the circumference, by synovial membrane. It contains large masses of fibrin, which is becoming organized, and some of which lies spread out on the surface.

The marrow is lymphoid and fatty in both bones.

SUMMARY.—Removal of large pieces of bone. In this case, after 40 days, with immobilization for 39 days, by the production of new cartilage, and the subsequent ossification of this cartilage, the ends of the bones are changed in their structure and outline, and are adapting themselves to the new mechanical conditions. A new synovial membrane is forming, but no articular cartilage. A joint is present, allowing excellent motion, but no articular cartilage has formed.

Dog 20, 304 days.

Mar. 17/14. Resection of right knee, removing about 5 mm. from the condyles and about 4 mm. from tibia. Patella left in place. The crucial ligaments were not divided. The semilunars were dissected out partly. The joint locked rather firmly in extension. Piece of tuberosity of tibia buried in the gluteal muscles.

July 9. Very little motion—antero-posterior—with crepitus.

Sept. 6. A few degrees of antero-posterior motion.

Nov. 20. Uses leg well. About 30° of motion in joint. No lateral motion.

Jan. 15/15. Killed by chloroform.

AUTOPSY.—Well nourished, healthy looking animal. Uses leg well. The knee is in the attitude of slight flexion. Range of motion about 30°. Nothing remarkable in scar at site of old wound. Patella freely movable, and quadriceps pouch is apparently intact.

Joint sawed sagittally. Apparently a joint cavity has persisted in the posterior part, but in this area the cartilage appears to have disappeared from the end of the femur. On the anterior portion of the condyles cartilage is present, and here also there is a small joint cavity apparently not connected with the other. Fibrous bands run from the cartilage on the femur to the head of the tibia. No cartilage can be distinguished at the line of section on the head of the tibia. The bone is extremely dense at the articular ends,—in fact, eburnated. The quadriceps pouch is divided off into compartments by fibrous bands. Both the cartilaginous surface of the patella and that on the front of the femur are covered by fibrous tissue. No indication of bony union is seen in any place.

HISTOLOGY.—A large slit is present between the two bones, divided roughly into two compartments, anterior and posterior, by bands of fibrous tissue. The ends of the bones are irregular, and are covered over a portion of their surface by cartilage, over a portion by fibro-cartilage, and over a portion by fibrous tissue. Over a small portion of

the surface of the tibia bare bone presents. The cartilage at its free surface is irregular, and is in tatters. Some of these tatters contain cartilage cells. The cartilage, in other words, looks like that of Type II arthritis ("arthritis deformans"). Areas of cartilage are seen, with cells in groups. The synovial membrane is present in the capsular portions of the joint cavity, thickened in its lymphoid elements. Anteriorly it is encroaching on the femoral cartilage, especially at its surface. The head of the tibia anteriorly is covered by fibrous tissue containing a few cartilage cells, which is much frayed out. The ends of the bones contain fatty marrow.

The joint between the patella and femur is lined throughout most of its extent by thickened, lymphoid, villous synovial membrane, which has encroached so greatly upon the cartilages as to cover most of their free surface. Where the cartilage is not encroached upon, its surface shows a tendency to tattering.

SUMMARY.—In this case very little bone was removed from the femur and tibia. Duration of plaster immobilization was not stated, but as all the dogs were put up in plaster, immobilization must have been attempted at least. After 304 days about 30° of motion is present. The bones are bound together by fibrous tissue, and are separated by a cleft whose walls present the characteristics of a joint cavity, namely cartilage and synovial membrane.

Dog 21, 255 days.

Mar. 19/14. Resection of right knee. Removal of 7 mm. from condyles of femur, and about 3 mm. from tuberosities of tibia. Patella left in. Operation as in 20. Piece of the head of the tibia buried in glutei. Plaster of Paris spica applied.

Apr. 3. Plaster of Paris removed, as it failed to immobilize the limb. The lower part had been entirely gnawed away.

July 9. Joint practically stiff.

Sept. 16. Dog was sick several months ago. Since then she has had a coarse tremor, a muscular twitching—asleep and awake. She has an opacity of the cornea. The joint is practically stiff, and a trifle sensitive when it is moved.

Nov. 20. Animal killed by chloroform anaesthesia. Well nourished and in good physical condition. Wounds healed per primum. Joint shows about 20° motion. Piece of bone in glutei found and removed. Patella is movable on the condyles. Sagittal section of knee-joint. Dense fibrous union is present. The ends of the bones for about 6 mm. are very dense and hard. In places between the bone ends there are

small spaces (two very small cavities), and a small area of softening in the dense bone of upper end of tibia.

HISTOLOGY.—The bone ends are united by fibrous tissue. The trabeculae near the line of junction are extremely thick and numerous, and the marrow about them is largely fibrous; farther away it is lymphoid. Between the two bones is dense fibrous tissue, with two or three clefts in it, but with nothing that resembles a synovial membrane, except in the anterior portion, near the region where the articular cartilage remains. (*Note.*—The cartilage was not removed completely at operation.) The femoro-patellar joint is in a good state of preservation. It is shut off below from the operated area by a band which passes from the fibrous tissue in front of the line of section backward and upward to the articular cartilage on the front of the femur, thus making a complete joint cavity. This band of fibrous tissue, on its joint side, is apparently being invested with a synovial membrane by an extension of the synovial membrane lining the posterior surface of the patellar tendon below the patella. Following the femoral cartilage downward, one sees below the band described another small cavity, lined on one side by the femoral cartilage with more or less fibrillated surface, and on the other by synovial membrane. Tracing down still further, one sees the cartilage change to fibro-cartilage. At its surface are two or three cavities, containing bone detritus. This fibro-cartilage then merges into fibrous tissue between the tibia and femur. Blood-vessels are pushing up into this fibrous tissue from the bone beneath it, giving one the impression that the fibrous tissue is being converted into bone.

In the head of the tibia is a rather large excavation filled with organizing blood-clot and lined by fibrous tissue, continuous with that on the anterior aspect of the joint. The excavation is surrounded by bone whose trabeculae are very thick, and whose marrow is fibrous. It is to be observed that the fibers of the tissue which binds the bones together do not pass directly across from bone to bone, but pass into the joint cleft from the periphery and then into one bone or the other. In other words, ankylosis is being brought about by bands of fibrous tissue between each bone and the capsule.

In the tibia head near the excavation, at the outer margin of the area of dense bone noted above, is an island of cartilage connected on one side by a narrow isthmus with a bone trabecula, and in various places about its periphery with the fibrous tissue in the marrow. Here and there at its periphery it is becoming ossified. It contains areas of marrow, about which also ossification is going on. In the neighborhood,

and in fact all about the extreme end of the bone, new bone is being formed on the trabeculae through the medium of fibrous tissue. In one or two places this bone, which we consider new-forming, presents the typical appearance of what is known as rarefying osteitis,—Howship's lacunae, osteoclasts, etc. Farther from the joint the marrow contains bone detritus, and the trabeculae are normal in density. Between this area and the one described above, with dense bone and fibrous marrow, the marrow is lymphoid, and, near the periphery, fatty.

In the end of the femur is a sharp, deep excavation, partly filled by fibrous tissue, and containing cavities, some lined by synovial membrane.

SUMMARY.—Removal of small amount of bone. Immobilization ineffectual. Duration of experiment, 8 months. The sclerosed ends of the bones are bound together by fibrous tissue and by fibro-cartilage, containing clefts. Each bone contains a small cavity in its end, filled or partly filled by fibrous tissue continuous with the periosteum. Neither bone is hollowed out to receive the other, nor is there any flattening out of their apposed surfaces to prevent motion. No evidence is present of any building up of bone about the periphery of either bone.

Dog 22, 47 days.

Mar. 23/14. Resection of right knee. Removal of 3.5 mm. from the femoral condyles, and 3 mm. from the tibial tuberosities, doing all with chisel, and extending the denudation all over the front of the condyles and in intercondyloid notch. Patella left in place. One condylar piece buried in the glutei.

Apr. 4. Plaster removed, as it had been entirely gnawed away below operation wound.

May 9. The dog had been ailing for some time, but grew better. This morning she seems sick again—rapid respiration and groaning. Killed by chloroform anaesthesia.

AUTOPSY.—Panniculus on abdomen well developed. Lungs show wide areas of consolidation, as of a new process engrafted on an old. Areas of engorgement. In other places the bronchi exude pus. Intestines empty, stomach also.

Knee possesses about 20° of motion; removed. Red marrow in shaft of femur.

Aug. 11. Bones sawn sagittally. The marrow canals (red marrow) come down almost to the epiphyseal lines (still present) in both

bones. The bone ends are tied together by fibrous tissue, but there is no joint cleft. Ordinary spongy bone (not sclerosed) in bone ends. Patella is not adherent.

HISTOLOGY.—The bones are tied together by fibrous tissue, in which are clefts. Some of these clefts are lined by a tissue identical with synovial membrane. The articular cartilage is present posterior to the end of the tibia,—that is, on the posterior surface of the epiphysis,—but nowhere else on this bone. Synovial membrane is pushing over its surface.

In the anterior and posterior portions of the epiphysis of the tibia, bone and marrow exist. The marrow is lymphoid, and its cells show a marked tendency to gather along the margins of the trabeculae. In the middle of the epiphysis the bone and marrow have practically disappeared, and their place is taken by fibrous tissue in which are a few small fragments of bone trabeculae which have lost their bone cells. The floor of this area is formed by the epiphyseal cartilage; anterior to this area, between it and the bone in the anterior portion of the epiphysis, is a mass of tissue, transitional between fibrous tissue and cartilage, and containing islands of new-formed cartilage. Lime-salts are being deposited in the islands of cartilage next the bone.

Posterior to the area, between it and the bone in the posterior part of the epiphysis, is a smaller area of cartilage.

The lower end of the femur is covered by fibrous tissue in which are a few stray islands of cartilage. It is convex, rounded off, and applied to the fibrous area in the tibial epiphysis.

A joint is present between the femur and patella, and the synovial membrane is spreading in over their cartilages, and has formed a layer of fibrous tissue over them near their circumference, tapering off toward the center.

SUMMARY.—Very little bone removed. Partial immobilization only for 12 days. Duration of experiment, 47 days.

From the persistence of bone anteriorly and posteriorly in the tibial epiphysis, with its disappearance in the middle, and from the presence of cartilage anterior and posterior to the middle area, and from the persistence of the epiphyseal line at its base, it appears probable that a new socket is being formed for the end of the femur in the head of the tibia, which socket eventually would have been lined by cartilage. Apparently the medullary canal has extended in both bones toward the joint. The bones are united by fibrous tissue containing clefts, some lined by fibrous tissue.

SUMMARY

Dog	Amount of Bone Removed	Immobilization	Duration of Experiment	Result
		Days, unless otherwise noted		
2	Small	40	2 yrs.	Joint cavity present, and bone ends partly covered by new-formed cartilage. Synovial membrane present. 25° of motion.
4	Small	69	122	Head of tibia hollowed out. Ends of bones tied together by fibrous tissue, allowing about 30° motion.
5	Small	60	21 mos.	Heads of bones covered by fibro-cartilage. A well-marked joint cavity is present. Motion limited by flattening of bone ends.
6	Small	3	462	Ends of bones bound loosely together by fibrous tissue. About 50° of motion.
7	Small	98	23 mos.	New joint formation. Ends of bones almost covered by fibro-cartilage. Synovial membrane in capsule.
8	Large	54	432	Bony union.
9	Large	35	98	About 90° of motion. No histological examination.
10	Large	38	208	The bones are united loosely by fibrous tissue, in which are clefts, some lined by synovial membrane. Free motion.
12	Large	7	14	Free motion. Cavity between bones lined by fibrin.
13	Large	30	88	Bony union.
14	Large	18	117	Formation of new joint, but without articular cartilage. Synovial membrane lines the capsule. Free motion.
15	Large	42	240	Loose fibrous ankylosis, with persistence of synovial cavities.
16	Large	8 wks.	97	Firm union by fibrous tissue and fibro-cartilage.
17	Large	Few	347	Convex end of femur received into concavity of tibia. Bones united by fibrous tissue, fibro-cartilage and cartilage. A few degrees of motion persist.
18	Large	40	317	Bones united by fibro-cartilage and cartilage.
19	Large	39	40	Joint is present, but no articular cartilage. Motion is rather free.
20	Small	?	304	Joint with cartilage and synovial membrane is present, allowing about 30° of motion.
21	Small	Few	8 mos.	Ends of bones united by fibrous tissue, allowing about 20° of motion.
22	Small	12	47	Ends of bones united by fibrous tissue, containing fat. About 20° of motion possible.

CONCLUSION

It is seen from a study of our sections and histories that our results fall roughly into four groups:

1. Bony union—two cases.
2. Firm fibrous, fibro-cartilaginous, and cartilaginous union.
3. Loose fibrous union, with or without synovial cavities.
4. The formation of a new joint, with a joint cavity, and a covering of the bone ends by cartilage.

In a good proportion of cases, the head of the tibia is broadened antero-posteriorly and made concave to receive the convex end of the femur. The broadening is accomplished by means of new bone, made from cartilage and from fibro-cartilage. The concavity may be increased by the absorption of the bone trabeculae in the middle. The concavity may be deepened also by the production upward of tongues of bone anteriorly and posteriorly on the tibia.

It is impossible to tell from our cases just what factors influence the result. Length of time, amount of bone removed, and duration of immobilization do not seem to constitute the deciding factor in the persistence of motion, though it may be said that if much bone be removed, a true joint with articular cartilage will not form, and that if little bone be removed, bony ankylosis will not ensue.

In some cases the new joint appears to have been formed by the spreading in of the synovial membrane over the ends of the bones. This synovial membrane later was transformed into cartilage.

The transformation of synovial membrane into cartilage in the capsule has been noted; *e. g.* dog 2.

The replacement of cartilage by fibrous tissue, with or without synovial membrane at its surface, has also been noted.

Our results confirm the contention of various other writers, that cartilage and synovial membrane are similar tissues, and that each may replace the other.

New articular cartilage, then, may form on the ends of denuded bones. The problem in producing a new joint is to ascertain what the conditions are which cause it to form.

If motion persists after a dog's knee is resected, as it does in the majority of cases, whether by loose fibrous union or by the formation of a true joint, then the results of experimental arthroplasties by the interposition of various tissues, must be thrown out, as a case of ***non sequitur.***

These results cannot be utilized as applying to human joints. If a human knee be resected, by whatever method, ankylosis will result almost invariably. Whether the interposition of any substance will prevent this is another question, not to be decided by results obtained from simple resections of dogs' knees.

The thickening of the trabeculae in the ends of the bones in our cases was often a marked phenomenon. This thickening, this eburnation, may be the deciding factor against an ankylosis. Eburnation in the human subject is known to be a factor, at least, in the production of pseudoarthrosis; and in those forms of arthritis characterized by eburnation of the bone ends, Type 2, union of the bone ends never takes place. The result is much the same in this form of arthritis as that which is well shown in our dog 5.

Certain of our cases (*e. g.*, Nos. 2, 5 and 7), in which a new joint was formed, present a marked resemblance to cases of arthritis of Type II, *i. e.*, to the German arthritis deformans, the English osteoarthritis, Goldthwait's hypertrophic arthritis, Nichols and Richardson's degenerative form. The main features of the process are the same, namely, eburnation of the bone ends, with splitting up and fibrillation of the cartilage basement substance, and the peculiar arrangement and form of the cartilage cells. Weichselbaum * noted these changes in an examination of two old resected human elbows. He assumed that the joint which had formed after the resection had been damaged by a supervening ("später aufgetretene") arthritis deformans.

The marrow about the region of the resection often takes on a fibrous or fatty character. Usually it is exclusively fatty and fibrous.

In those of our cases where the patella was left, its cartilage was overlaid and partly replaced by fibrous tissue,—continuous with synovial membrane, and often covered by it. The cartilage was also perforated, and the fibrous tissue at its surface communicated through the perforation with the fibrous tissue in the interior of the bone. The joint evidently was being obliterated in this manner. The bone trabeculae in the patella also tend to disappear.

In one or two instances cartilage appeared in the patellar ligament, where it articulated with the condyles of the femur under changed conditions.

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* Weichselbaum, A.: "Anatomische Untersuchung von drei geheilten Gelenkresectionen." *Archiv für klinische Chirurgie,* 1874, XVI, 248. This peculiar conception of these changes by the Germans, as an etiological, pathological and clinical entity, crops up constantly in their research work on joints.

REACTION OF THE TISSUES OF THE KNEE-JOINT OF THE RABBIT TO INJURY

By LEONARD W. ELY and JOHN FRANCIS COWAN

I

INCISING, SCRAPING AND BURNING THE CARTILAGE OF THE PATELLA OR OF THE FEMUR.

The following series of experiments was undertaken to determine the effect of an injury to the joint tissues of rabbits, and to observe the processes of repair in them, especially to observe the reaction and the repair of the articular cartilage.

Very little experimental work has been done until quite recently upon the joint cartilage.* Many experiments have been done upon the cartilages of the ribs, but these have a perichondrium. A perichondrium does not exist in the articular cartilage, except in foetal life and shortly afterward. Hence results predicated on experiments upon rib cartilage

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*Archangelsky: "Regeneration des hyalinen Knorpels." *Centralblatt für die medicinischen Wissenschaften*, 1868, VI, 658.

Experiments on dogs (what cartilages the author does not say).

1. Die Narbe in dem verwundeten Knorpel besteht anfänglich aus Bindegewebe, welches sich vom Perichondrium ausbildet und in der Regel an zelligen Elementen reich ist.

2. Nach Verlauf einiger Zeit geht dieses narbige Bindegewebe allmählich in Knorpel über, indem von vornherein die Bindegewebskörperchen mit doppelt contourirten Kapseln umbilden, so dass man zuerst einen Faserknorpel vor sich hat, und später bildet sich aus diesem letztern der wahre hyaline Knorpel, welcher den Raum der Wunde einnimmt.

3. Die knorpligen Ränder der Wunde nehmen keinen Antheil bei der Bildung der Narbe in einem verwundeten Knorpel und zeigen dabei weder progressive noch regressive Veränderungen.

Redfern: "On the Healing of Wounds in Articular Cartilages." *Monthly Journal of Medical Science*, London, 1851, XIII, 201.

Operations on dogs' knees.

Conclusions:

1. Wounds in articular cartilages heal perfectly by the formation of fibrous tissue out of the cut surfaces.

2. The fibrous cicatrix consists of white and yellow fibers, which are formed out of the intercellular substance of the cartilage, and out of the nuclei of its cells, respectively.

are not applicable to the joint cartilage. Axhausen (*Archiv für klinische Chirurgie*, 1912, XCIX, 519), from experiments upon dogs and rabbits, stated that lesions typical of "arthritis deformans" followed injury to the cartilage by an electric needle, namely a "dissecting" inflammation in the marrow, and the formation of "Randexostosen" (lipping) at the circumference of the cartilage of the injured bone and of that of the other bones of the articulation. He affirmed, in other words, that a small localized injury to a joint cartilage set in motion a pathological process involving not only the cartilage but also the synovia, the marrow, and the bone. It is to be noted that an injury of the cartilage by an electric needle would likely involve the marrow beneath, and therefore in our experiments we chose methods of injury which could be regulated more exactly.

Three sets of experiments comprise our series:

1. Making a circular incision through the cartilage on the posterior surface of the patella, or through that in the intercondylar groove on the anterior aspect of the femur.

2. Gouging out a small piece of the cartilage on the under surface of the patella.

3. Burning a small area of cartilage on the anterior surface of the intercondylar groove of the femur with an actual cautery.

In all three sets we endeavored to wound only the cartilage, though we occasionally damaged the synovial membrane by accident, and sometimes burned through the buttress of bone beneath the cartilage.

The animals employed were rabbits. All operations were done under ether anaesthesia, and with aseptic precautions. Only two or three infections took place. Extreme care was used to damage the joint tissues as little as possible by rough handling. At various intervals up to 360 days the animals were killed, and the gross appearances of the joint tissues were noted.

The parts of the joint to be studied were removed, fixed with Orth's fluid or alcohol, and the bones were decalcified in 5% nitric acid. The material was run up through the alcohols and imbedded in celloidin. The sections, mostly 20 microns thick, were stained in haematoxylin and eosin, and by the van Gieson method.

Rabbit 1, 270 days.

Dec. 8/13. An incision was made about 3 cm. long on the lateral aspect of the right knee, curved, with convexity backward. Another

incision was made with another knife, opening up the knee-joint. The patella was drawn medially, exposing the condyles of the femur.

With the point of the scalpel, the cartilage over the front of the inner condyle was incised in a circle, whose diameter was about 3 mm. The attempt was made to run the point of the knife down to the bone. The wound was sutured up with two layers of catgut, and collodion was applied.

Sept. 4/14. Rabbit was sacrificed by blow on back of the neck. An abscess is present on right side of the chest, with thick, creamy contents. The joint was then opened by a medial incision. The synovia looks succulent and thickened. The old incision on the condyle can be identified as a slight irregularity in surface. A transverse section of the femur through operated site was put into Orth's fluid.

HISTOLOGY.—Sections of femur. In a number of these, one cut can be distinguished. It is closed throughout most of its depth, and a partial "lid" has been formed for it (a teat-like process) by the border nearest the periphery. While the sides of the cut are in close apposition, no union has taken place between them. The cut goes down into the buttress underneath. The rest of the cartilage is normal. No signs of lipping are present. Marrow is largely fatty, especially at the sides of the bone, but normal.

Rabbit 2, 270 days.

Dec. 8/13. Incision and preliminaries as in 1. The cartilage was removed with a gouge over an area of 3 mm. in diameter, from the inner condyle down to the bone. Wound sutured in two layers with catgut. Collodion.

Sept. 4/14. Rabbit killed. Ulceration of right side of face, in front and below the eye.

Wound healed *per primam*. No signs of incision; right knee-joint removed. Joint opened; articular surface of femur appears normal. No sign of injury; no lipping. On the posterior surface of patella, however, there is an irregular rounded, depressed area, 3 mm. in diameter, the surface of which is roughened. Patella—depressed area removed and placed in Orth's fluid.

Sept. 6. Specimen washed and placed in 5% HNO_3.

HISTOLOGY.—The hole is partly filled by pigmented material. The sides of the hole are rather rounded off, and are formed by cartilage, de-

generated at the extreme border of the area, and with the fibers turned down to make the rounding off. The bone, immediately beneath the gouged area, is necrotic. The marrow is mostly fatty; in one area directly beneath the injury it is fibrous and oedematous.

(The results of the examination of this case indicate that the description of the operation was faulty. Evidently the patella was injured, not the femur.)

Rabbit 3, 311 days.

Dec. 12/13. Incision as before. Patella drawn aside and turned over. From its under-surface a piece of cartilage about 3 mm. in diameter was removed, exposing the bone.

Suture, and collodion dressing as in 1 and 2.

Oct. 19/14. Animal died last night. Autopsy to-day. Wound healed completely. Mass palpable on lateral aspect. Joint opened from above. The patella shows a slight irregularity at site of operation, but its surface is fairly smooth. The cartilage apparently has re-formed. Lateral to the patella and connected with it, is a white, smooth mass of cartilaginous material, measuring 8 x 15 mm., with long diameter longitudinally. It is a thin shell. Its surface is irregular. The lateral condylar ridge is irregular and eroded, and the lateral aspect of the condyle is irregular and eroded also. The synovial membrane is slightly injected, and seems to extend over the new cartilaginous shell. No lipping of the cartilage, but rather erosion. Tibia normal. The internal genitals, uterus and tubes, are large sacs full of the thick, cheesy matter so often found in these rabbits—pus infection.

Histology.—Patella and cartilage plate. Wounded area identified. It is empty in places (that is, in certain sections), in other places it contains pieces of necrotic cartilage. The cartilage near the border of the injury shows evidences of degeneration. The bone buttress appears to be thickened. The marrow is normal lymphoid. The trabeculae are thickened by the production of new bone from fibrous tissue.

At one side, the cartilage and bone shade into the "cartilaginous plate" noted above. This is composed of fibrous tissue and of fibrocartilaginous tissue—a transitional tissue, as Professor Ophüls describes it. Some of it is typically fibrous, some has cells with typical capsules.

The lateral condylar ridge is covered by cartilage with few cells. On its lateral aspect it is, so to speak, eaten out, and in the deepest part

of the excavation is a mass of fibrous tissue, which evidently is undergoing transformation into bone. Farther away from the joint line again —that is, on the far side, adjoining the excavation—a "hook" of bone has been built up. Underneath the layer of bone at the surface in this region the marrow is fibrous and oedematous, and in various spots elsewhere in the end of the bone, mixed in with the prevailing lymphoid marrow, are small areas of fibrous marrow.

Some sections show the production of new, live cartilage.

Rabbit 4, 346 days.

Dec. 12/13. Same operation as in 3, namely, scraping off of cartilage from under surface of patella.

Nov. 22/14. Rabbit died.

Nov. 23. Autopsy.

Knee from outside is apparently normal, movement free; no sign of operation. Joint opened from above. No sign of active inflammation can be seen in the joint. Wound in cartilage of patella can be identified as a slight irregularity in the surface; under magnifying-glass this irregularity appears to be slightly depressed. The tissue which has filled in the wound appears to be cartilage.

The cartilage on the anterior intercondylar space is slightly irregular over an area approximately the same as that of the wound in the patellar cartilage. An erosion of the medial aspect of the medial condyle is present.

AUTOPSY.—Left kidney greatly enlarged, somewhat irregular, somewhat mottled. Right kidney similar in appearance. Liver evidently sclerotic. Spleen apparently smaller than normal. Tubercles in left lung. Right lung normal.

HISTOLOGY.—*Patella.*—Two cuts of the cartilage can be seen in cross-section. One is very faint, is closed in at the surface by a pressing together of the two sides, and does not extend down to the bone. It runs practically perpendicular to the surface. The other is deeper, in some sections extends down into the bone, and has an oblique course (except at its deepest part). Its pointed cartilaginous border forms a sort of lid for the opening. The point is directed towards the nearest border of the cartilage,—that is, it is attached to the part of the cartilage included in the circular cut. It contains few cells.

The wound was entirely healed, and the fur had grown over site of operation. On opening the joint it was found normal to gross inspection—no signs of inflammation whatever. On close inspection the line of incision in the patellar cartilage could be distinguished, and running out from it thin, faint cracks could be seen in the cartilage. The cartilage within the incision was whiter than that outside. It lacked the purplish tinge of the latter. Patella into Orth's fluid.

HISTOLOGY.—Cut recognized through cartilage. Bone torn in cutting. Hence more slides to be done.

(Later), Other slides. The cuts (3) can be easily recognized. Their sides are separated. There is no healing over at the surface, but in two of them one border has a tendency to lap over the other at the surface. The bone is so badly torn by the microtome that nothing can be said about its structure. The cartilage shows little if any degeneration. The synovia is congested.

Rabbit 7.

Lost some time after operation.

Rabbit 8, 8 days.

Dec. 18/13. Duplicate of previous operations of incising cartilage of right patella in a circle of 3 mm. in diameter.

Dec. 26. Rabbit died.

Dec. 27. *Post-mortem.*—Cause of death not ascertained. The wound was evidently healing normally. The synovia showed no signs of inflammation. No fluid in joint. Cartilage irregular where it was incised. Patella put into Orth's fluid.

HISTOLOGY.—Cuts recognized; they are filled with detritus. The surface of the cartilage presents several small rifts, which we regard as artifacts. The cartilage appears normal otherwise. Synovia oedematous.

The marrow is missing from the interior of bone, and the trabeculae seem to have been torn away also.

(Later), Other slides. In some of these, the circular cut has evidently been caught near the periphery by the knife, so that the two cuts are close together. In these the cartilage looks as if it had been squeezed out. It lies in two ribbons out on the surface. The cartilage here at the

injured area has lost its columnar arrangement entirely, and is degenerated in places. It consists almost exclusively of basement substance.

In other slides the two cuts are wide apart. The lateral borders here overlap the central.

The fixing is poor, and details are not sharp. The bone is torn. The marrow is congested.

Rabbit 10, 31 days.

Dec. 19/13. Duplicate of previous operations of gouging out 3 mm. of cartilage from under surface of right patella. The cartilage appeared slightly abnormal, as if it had been injured.

Jan. 19/14. Rabbit killed. Wound healed completely; its site could not be determined. Joint synovia normal to gross inspection. Area of cartilage destruction plainly visible. Both patellae into Orth's fluid. Material lost.

Rabbit 11, 104 days.

Dec. 19/13. Duplicate of previous operations of incising cartilage of patella of right knee in a circle 3 mm. in diameter. Subsequent course uneventful. Wound healed.

Apr. 3/14. Death yesterday.

AUTOPSY.—Fur has not grown out completely, but there is no sign of the operation wound.

Right knee swollen, fluctuating, flexed, and limited in motion. Lump about the size of a bean can be felt in it. Thigh is drawn up toward body. When skin was removed, a marked injection of the vessels on anterior surface of thigh was evident. The lumps could be seen to be yellowish masses, apparently discrete. Joint opened. It is full of cheesy yellow material. The cartilages are roughened. A large part of the joint surface of the patella has been eroded. The lower portion of it presents as bare bone.

Nothing worthy of note in the viscera.

Infection. Not examined microscopically.

Rabbit 12, 278 days.

Dec. 22/13. Duplicate of previous operations of a circular incision through cartilage of right patella, 3 mm. in diameter.

Sept. 26/14. Rabbit has a sausage-shaped irregular mass about 20 cm. along under skin of back. It is soft and fluctuating.

Incision.—The mass was encapsulated, and for a large part of its extent the dissection was carried out without breaking through this. Then it broke. The cavity ran up under the skin almost to the neck (from the tail). The capsule posteriorly was thick, anteriorly (near the neck) it was very thin. The contents were like Camembert cheese. Wound sewn up. Rabbit died about fifteen minutes after removal from table.

AUTOPSY.—The incision in the cartilage is easily recognized. The cartilage within the incision is white in contrast to the pink color of that outside. Otherwise the joint is absolutely normal in appearance.

HISTOLOGY.—The exact lines of incision cannot be determined. The cartilage, presumably at about the site of incision, is fissured in a number of places, and is more or less irregular in structure, though still preserving a columnar appearance. The fissures for the most part run down to bone. The subjacent bone shows small blood-vessels in the marrow spaces.

The overlapping border of a certain number of the cuts points toward one margin, and that of the other cuts toward the other; roughly they point toward their nearest joint margin. The overlapping border is the central one.

Marrow is a mixture of lymphoid and fatty.

Rabbit 13, 149 days.

Dec. 22/13. Duplicate of previous operation of gouging out a piece of cartilage 3 mm. in diameter from the under surface of patella.

May 20/14. Killed by a blow behind neck. The animal has a peculiar horny condition of his untagged ear.

AUTOPSY.—The ear condition was due to "mites," which had built up a structure like a hornet's nest.

The knee wound has healed completely, leaving no trace in the joint. Joint put into alcohol.

Examination of Joint, Aug. 13. Joint laid open by an incision medial to the patella. Cartilage of patella is somewhat irregular. An irregular depression in the form of a ring can be made out, but inside this ring the cartilage seems to have regenerated. Rest of joint appears normal. No lipping or signs of "arthritis deformans."

HISTOLOGY.—On one side of the section the synovia has grown over the unwounded cartilage in the shape of a fibrous band, right up to

the border of the wounded area. It is attached to the cartilage at the border of the wounded area, and for some distance from it, but toward the periphery it is lifted away. At or about the place where the fibrous band ends, the structure of the cartilage becomes extremely irregular. The cells are arranged in groups instead of in columns, and are rather

Low-power photmicrograph showing regeneration of cartilage, probably by means of the spreading inward of the synovial membrane in the form of a band.

few in number. Then comes a small gap or rift in the cartilage, not reaching down to the bone; and still farther away from the fibrous band, at a distance corresponding to the usual width of the cartilage wound another small slit is seen. We have here a *regeneration* of cartilage, probably by means of the synovial membrane spreading in from the side.

Rabbit 14. Lost.

Rabbit 15. 3 days.

Dec. 23/13. Burn as usual. 3 mm. in diameter, with actual cautery through cartilage on under surface of patella. The cautery slipped, probably damaging synovia. One of the *testes* was greatly enlarged, and hanging down in a covering of what looked like thick, dirty skin. It was ligated, tied off, and put into Orth's fluid.

Dec. 26. Died.

Incision.—The mass was encapsulated, and for a large part of its extent the dissection was carried out without breaking through this. Then it broke. The cavity ran up under the skin almost to the neck (from the tail). The capsule posteriorly was thick, anteriorly (near the neck) it was very thin. The contents were like Camembert cheese. Wound sewn up. Rabbit died about fifteen minutes after removal from table.

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Dec. 26. Died.

AUTOPSY.—Did not show cause of death. The wound was evidently healing well. The synovia of the entire joint showed a violent reaction—it was injected with blood. No fluid in the joint or evidence of sepsis. The burnt hole in the cartilage was evident. Patella put into Orth's fluid.

HISTOLOGY.—Burnt area in cartilage identified. In one or two of the slides a thin scale of deeply pigmented material occupies part of the hole. The burn goes down almost to the bone beneath, but a small layer of cartilage is left, whose structure is practically obliterated. The marrow shows congestion. The cartilage at the side of the burn, where it is not destroyed absolutely, is degenerated, and does not stain properly.

The synovia is injected and oedematous. In two or three slides the burn is at the periphery of the patella, so as to injure the synovia, which is thickened and oedematous. The bone of the patella has been torn so badly in cutting that little can be told about it. (Later), More slides show the same.

Rabbit 16, 360 days.

Jan. 5/14. Right knee. Incision as before. With actual cautery at very dull red-heat, a hole about 3 mm. in diameter was burned in the articular cartilage between the condylar ridges, anteriorly. Suture, and dressing with collodion.

Dec. 31. Apparently in perfect health. Killed by blow on neck.

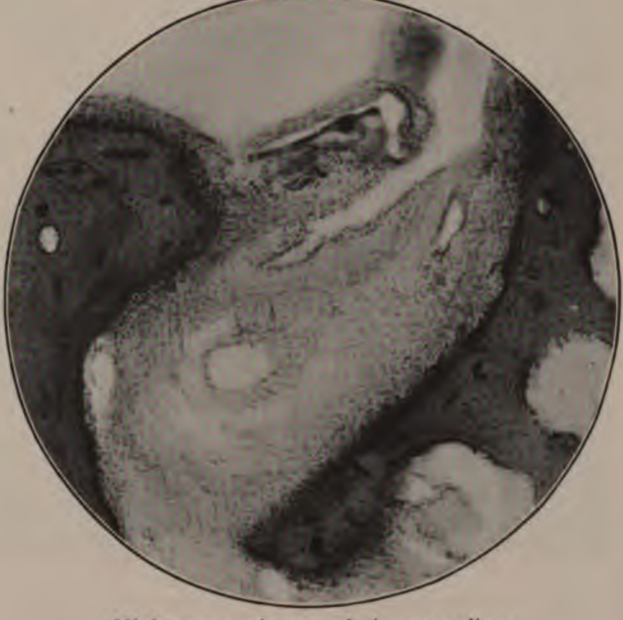
Joint from outside appears perfectly normal. Movements normal. Joint opened from above. Burned area identified. It is slightly depressed and roughened and has a small pigmented area in its center with a faint halo surrounding it. In other respects the joint appears perfectly normal. No lipping of cartilage or of bone. Synovia is not injected nor thickened. Cross-section with wounded area put into 80% alcohol.

HISTOLOGY.—Burned area identified. The cartilage is absent there, and the bone is bare. In the center is a hole through the bone. The "halo" is caused by dead cartilage.

The various slides present various pictures of the tissues in and about the hole. In one the bone buttress looks like a trap-door turned down. In others a bony layer has formed across at a lower level. Again in others there is no bony layer between the joint cavity and the marrow.

The hole is plugged almost to the joint surface by fibrous tissue with spaces in it, which apparently are communications with the joint—prolongation of the joint cavity—cut across. This fibrous tissue can be seen undergoing transformation into bone, as if to shut off the marrow from the joint; and according to the place at which the microtome knife

Low-power photomicrograph showing absence of cartilage at site of burn. The cautery penetrated the bony buttress, and the hole is plugged, in this picture, almost to the surface, by fibrous tissue. A new bony buttress is forming at an angle. The cartilage has not regenerated.



High-power picture of the preceding.

Rabbit 17, 241 days.

Jan. 5/14. Duplicate of 16; burning of a hole about 2 mm. in diameter in the articular cartilage of the intercondylar region in front of femur. Actual cautery at dull red-heat. Suture, and collodion dressing.

Sept. 3. Rabbit has a large abscess under chin in neck. Killed. Wound completely healed. Joint removed. It is apparently perfectly normal. No Randexostosen. Slightly anaemic. Opened by lateral incision. The burned spot on the femur appears as a non-pigmented depression about 2 mm. in diameter, apparently running down to bone. Its base is rough. About this area is an areola, slightly depressed, about 5 mm. in diameter.

HISTOLOGY.—The wounded area in the cartilage had been lost by careless cutting.

Rabbit 18, 4 months.

Jan. 6/14. Duplicate of 16 and 17. Burning. Rabbit died about four months after operation.

The joint is apparently normal. The thigh is drawn up against the abdomen, and in the groin and on the anterior aspect of the lower end of the femur are soft fluctuating swellings about the size of pigeon's eggs. On the inner aspect of the knee is what appears to have been a third of these collections, but it has evidently ruptured, and now is half filled with a yellow cheesy material. The joint itself seems freely movable. These collections of purulent material are connected by strands; in one of these strands there is a cheesy lymph node. There are other smaller lymph-nodes filled with similar material. A section of the larger masses shows a greenish-yellow material like over-ripe Camembert cheese.

Right knee-joint removed and put into 80% alcohol.

AUTOPSY shows a jelly-like substance in pericardium and an extensive right pneumonia.

Aug. 26. Joint opened. The wounded area is manifest as a depressed area, surrounded by a faint halo. Center, 2 mm. in diameter, is roughened and depressed. Halo surrounding this—5 mm. in diameter—smooth and slightly depressed. Placed in 5% HNO_3.

HISTOLOGY.—The burn in the cartilage is manifest as a depressed area, partly filled with fibrous tissue in which are seen some irregular spaces, and some areas containing pigment and detritus. Two or three blood-vessels can be distinguished in the fibrous tissue. The buttress of bone immediately beneath the cartilage is also gone, and the depression goes much below it; but underneath the burned area a new buttress of

Low-power photomicrograph. The cautery has penetrated the bony buttress. The injured area is manifest as a depression partly filled by fibrous tissue. Note new buttress formed at a lower level. No regeneration of cartilage.

High-power photomicrograph, showing masses of pigment and detritus in the new fibrous tissue.

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High-power photomicrograph, showing masses of pigment and detritus in the new fibrous tissue.

bone has been built, at a lower level than the other, but continuous with it, as if to shut off the marrow from the joint.

The cartilage over the rest of the joint looks normal, except for small degenerated areas. No evidence of any new cartilage production. The marrow is normal. No evidence of lipping or of "arthritis deformans."

Rabbit 19, 225 days.

Jan. 6/14. Duplicate of 16, 17, 18 (burning hole through cartilage between condylar ridges of femur).

Aug. 22. Rabbit died last night.

AUTOPSY.—Fur has grown over joint. No sign of any lesion of joint. Skin removed; no sign of incision. Joint removed and put into formalin. It presents no sign of abnormality, prior to opening.

Lungs are engorged. Apparently the animal died in the first stage of pneumonia.

Aug. 24. Joint opened, through incision in capsule medially to patella. Circular depression, 3 mm. in diameter, extending across trochlear surface from external ridge. In center of this is a black pigmented spot about 1 mm. in diameter, apparently covered by cartilage. This area is slightly roughened. Patella, even where it plays over roughened surface of femur, shows no abnormality.

Aug. 26. Cross-section through trochlear surface at level of burned area.

HISTOLOGY.—Burned area identified. Its cartilage and most of its bone buttress are gone. It contains a little detritus, and is covered over by a pigmented strip of burned cartilage. In the hole is a group of cartilage cells, staining well. The necrotic covering extends over most of the burn, but at its side an area of fibrous marrow can be seen communicating directly with the joint. The cartilage which remains beyond the limits of the actual burn is dead. In the bone, immediately under part of the degenerated cartilage, are short columns of cartilage cells arranged almost perpendicularly to the surface. The marrow shows two or three areas of fibrosis immediately beneath the burned area. Otherwise it seems to be much more fatty than normal.

Rabbit 20, 59 days.

Jan. 14/14. Duplicate of 17 (burning the cartilage with cautery point). The exposure was clumsy, and the joint tissues were injured. Also the cautery slipped, burning downward on the patella, and wounding synovia.

Mar. 10. Animal died last night after giving birth to a litter of rabbits.

AUTOPSY.—Exudate in pericardium. Right pleural cavity full of purulent exudate; left pleura same. Consolidation of both lungs. Fibrinous exudate on visceral pleura.

Right knee-joint operation. Wound is healed completely. Joint opened by transverse incision. It presents no signs of inflammation, except possibly a slight injection of the synovial membrane near its line of reflection to the cartilage. The burned area of cartilage appears as a black ellipse, about 3 x 1 mm., with its long diameter transverse (running between the two condyles). Lower end of femur removed and put in Orth's solution.

HISTOLOGY.—The cartilage has been destroyed at site of injury. A thin layer of structureless, irregular, pigmented (brown to black—van Gieson, and H. & E.) material takes its place partly. Beneath this the various slides show different pictures.

1. Under most of the area is bone, some living and some dead, the living and dead side by side. Beneath the center of the area, however, there is an area partly filled by a mass of cartilage. The rest of the area is vacant toward the joint from the mass of cartilage. This mass of cartilage is continuous on its deeper aspect with bone, as if it were forming bone. The layer of bone beneath the burn in this slide is rather thin in most places. The marrow beneath the burn is fibrous and oedematous in character.

2. Other slides show no traces of the space half-filled by a mass of cartilage, or a thinning of the bone, but rather a thickening of the bone, some living and some dead. The deep surface of this bone shows evident new bone formation by fibrous tissue in marrow. The dense bone contains a few marrow areas near the surface. Not so much oedematous fibrous marrow is present in these slides as in the first set. The marrow areas near the surface contain cells that look like cartilage cells, and they are surrounded in places by new formed bone.

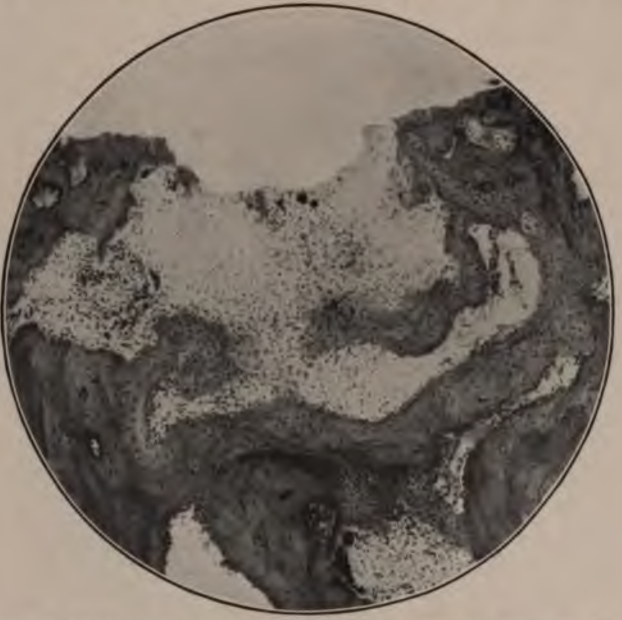
3. Other slides show very little bone under burned area, and that in the form of trabeculae, some living and some dead, among which are fibrous marrow and small groups of cartilage cells.

All the cartilage is eosinophilic.

There are absolutely no signs of any change in the joint or marrow or bone at a distance from the site of the injury.

The unwounded cartilage looks normal. Its cells are arranged in columns perpendicular to the surface, except near the surface, where the columnar arrangement ceases.

in places thinner, and seems to be undergoing a transformation into bone. (This looks as if the cautery had gone down into the bone.)



High-power photomicrograph from another section, without the strip of necrotic bone. This shows the buttress of bone formed at a lower level, and the conversion of the fibrous tissue into bone.

The bone trabeculae appear quite thick under the burned area. For a short distance under the cartilage the marrow is fatty, further toward the shaft it is lymphoid.

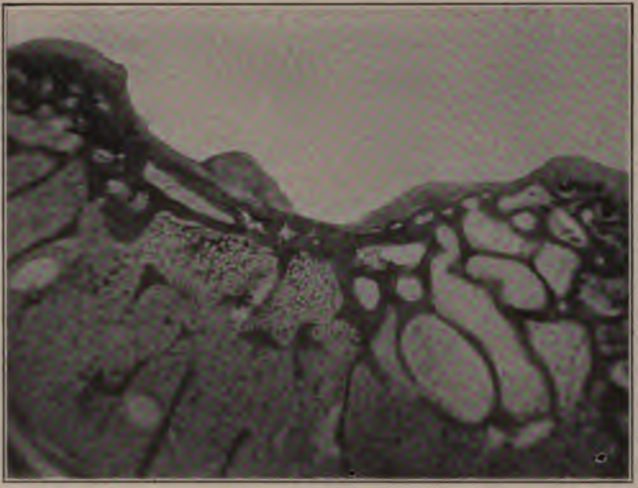
Rabbit 24, 298 days.

Young rabbit.

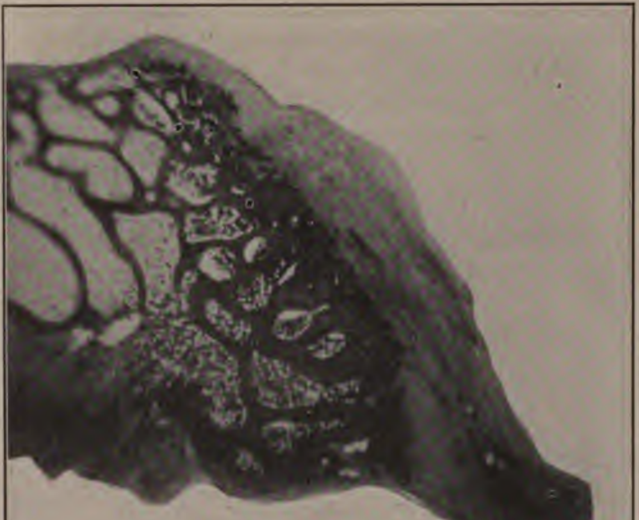
Jan. 22/14. Duplicate of preceding operations of burning a hole in the cartilage of the lower end of the femur. Suture with catgut.

Nov. 16. Rabbit killed by blow on back of neck. No sign of operation. Joint is perfectly movable, but feels broader from side to side.

Joint opened from above. Patella has been dislocated medially—accounting for the broadened joint. The patella has formed on the femur an articulating cartilaginous-like surface covered with firm tissue. Between the condylar ridges is a depressed area, corresponding to burn. It is covered by white, fibrous tissue. From this area to the synovia lateral to the patella is a strong, firm, glistening, grayish band of fibrous tissue. From the lateral aspect of lateral condyle to the synovia are sim-

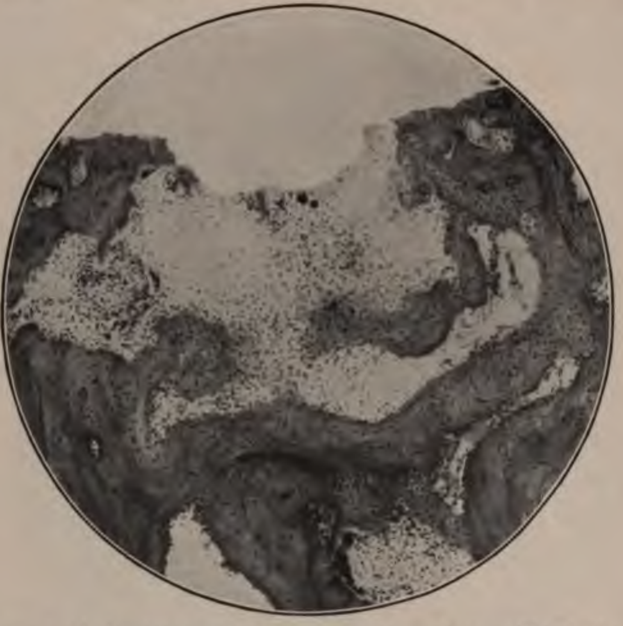


Low-power photomicrograph of femur at site of burn. The cartilage is absent in the intercondylar groove, and fibrous tissue covers the bone. The exact location of the burn cannot be determined.



High-power photomicrograph, showing the fibro-cartilage formed on the medial aspect of the femur for the new articulation with the patella.

in places thinner, and seems to be undergoing a transformation into bone. (This looks as if the cautery had gone down into the bone.)



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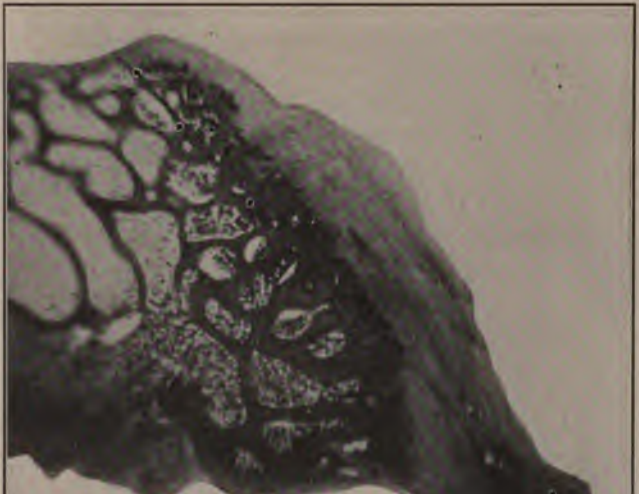


High-power photomicrograph, showing the fibro-cartilage formed on the medial aspect of the femur for the new articulation with the patella.

ilar but finer bands. The synovia appears thickened, but not injected. The tissue directly over the burn (that is, on under surface of quadriceps aponeurosis) just lateral to the adhesion is thickened, white, glistening, and firm; it appears cartilaginous (new forming patella?).

A, Section through burned area.

B, New articulating surface on medial aspect of medial condyle.

C, Cartilaginous tissue over burn.

(All into alcohol.)

HISTOLOGY.—*A*. Between the two condylar ridges the cartilage is absent. The layer of bone is covered by fibrous tissue, varying in thickness, but at no place very thick. Some of this fibrous tissue looks at its surface like synovial membrane. There is no collection of pigment, and the exact spot of burning cannot be identified. The fibrous tissue is continuous at the sides with cartilage, which covers the medial and lateral condylar eminences. Upon what is evidently the medial aspect is a ***thick layer of fibro-cartilage.***

The marrow in the bone ends is a mixture of fatty and lymphoid. New bone is forming in it.

B. New cartilage has been formed over the new articular surface, on the medial aspect of the bone, whose cells are arranged in irregular groups, rather than in the columnar normal manner. Its superficial layer is almost devoid of cells.

A large synovial villus is seen over the new articulating surface, which is becoming converted into cartilage. The passage from synovia to cartilage is so gradual that the transition is hard to establish. The bone trabeculae under the new articulation are thickened, and the marrow in places is fibrous, and is being converted into bone.

C. Dense fibrous tissue and muscle. No cartilage.

This case shows the transition of synovial membrane into cartilage.

Rabbit 25, Lost.

Young rabbit.

Jan. 23/14. Duplicate of preceding operations of burning hole in cartilage of femur. Catgut.

Rabbit lost.

Rabbit 26, 19 days.

Young rabbit. Infected.

Jan. 23/14. Duplicate of preceding operations of burning hole in cartilage on front of lower joint surface of femur. Poorly done. The cautery slipped and singed soft parts.

Feb. 11. Rabbit ailing. The right knee is drawn tightly up against the body, and cannot be pulled down. The wound is infected and discharges thick, cheesy pus. Animal killed by blows on back of neck, and an immediate autopsy done. Even after death the knee was held tightly to the body, and ordinary force could not straighten it. Skin removed from thigh, knee and groin, also from portion of abdomen. Great distension of the blood-vessels between the knee and groin, and in the groin. Cheesy masses along the vessels and in the groin. The knee was literally tied to the abdomen by the inflamed tissues. When these were divided the knee could be brought down. Knee-joint greatly distended—tissues outside it succulent. Knee-joint opened by transverse incision. It was filled with cheesy matter. The cartilages were practically normal in most of their extent. The site of the burn could be identified, and upward from this the cartilages seemed damaged, not so much eroded as "coated." The general autopsy revealed nothing of note.

A, Piece of femur with the burned cartilage area into Orth's fluid.

B, Femur into Orth's fluid.

C, Tibia and patella into Orth's fluid.

D, Soft parts of joint, and cheesy mass from groin, into Orth's fluid.

A. The cartilage over the femur has disappeared, except near the circumference, where it is degenerated or dead. The buttress bone layer has disappeared almost throughout. The marrow of the epiphysis is fibrous, but contains a few polymorphonuclears. The trabeculae show "Randapposition" and productive ostitis. Some rarefying ostitis.

In a few places the marrow appears to be bursting through the degenerating cartilage. Fibrous tissue lies beneath the cartilage. The marrow of the metaphysis shows a dense infiltration, mostly by polymorphnuclears, with a few plasma cells and a few eosinophiles; also many giant cells. The trabeculae are small and scant. The synovial membrane is thickened, and infiltrated with polymorphonuclears and endothelial leucocytes mostly. It has also areas of necrosis. The epiphyseal line seems normal.

B. Congested blood-vessels in marrow—polymorphonuclears and giant cells in great numbers.

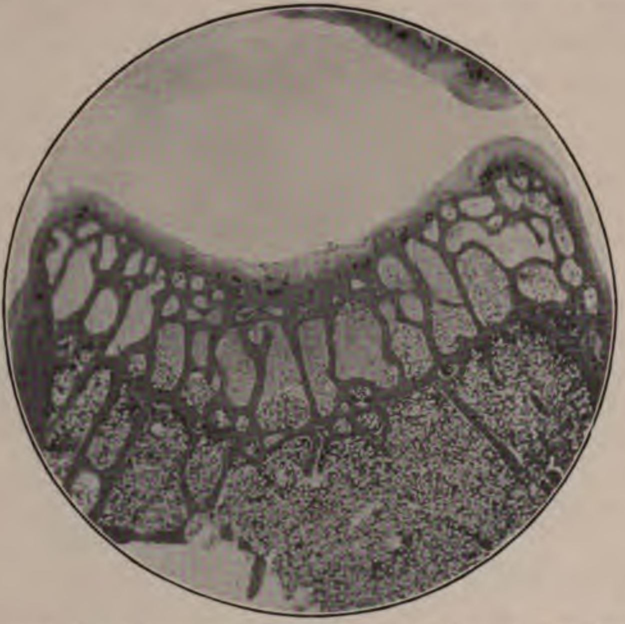
C. Patella. Cartilage degenerating at the surface. Marrow fairly normal. Much productive ostitis.

Rabbit 27, 255 days.

Young rabbit.

Jan. 26/14. Duplicate of preceding operations of burning hole 2 or 3 mm. in diameter in the cartilage on anterior surface of lower end of femur.

line of demarcation. The cartilage over the rest of the articulating surface is largely degenerated, especially in its more superficial portion. There is no normal cartilage on the articular surface—no columnar ar-



Low-power photomicrograph showing regeneration of cartilage over burned area.

rangement. Over the side of the condyle the cartilage looks normal. There is no sign of any exostosis. The marrow near the cartilage contains much fat and little lymphoid tissue. *Apparent regeneration of cartilage.*

Rabbit 29, Lost.

Young rabbit.

Jan. 27/14. Duplicate of preceding operations of burning hole in anterior surface on front of cartilage of condyles of femur.

Lost.

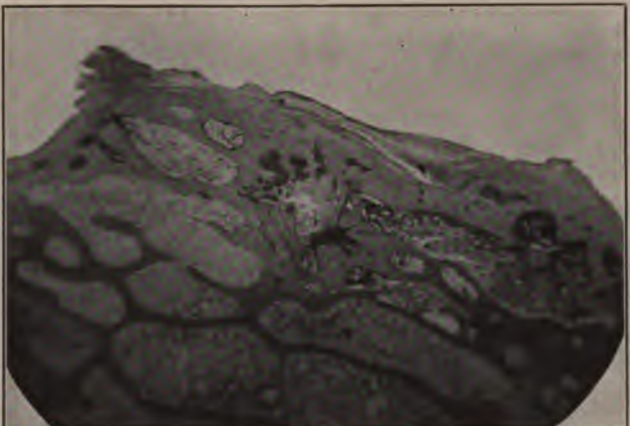
Rabbit 30, 127 days.

Young rabbit.

Jan. 27/14. Duplicate of preceding operations of burning hole, about 2 mm. in diameter, in cartilage on front of lower end of femur. Cautery slipped and seared cartilage in neighborhood.

June 5. The joint is in flexion, and cannot be fully extended, though motion up to a certain degree of extension is free. Flexion is free. The operated knee is enlarged.

Low-power photomicrograph. The center of the burned area shows a small projection or teat (A). This is composed of fibrous tissue and bone. The bone injured at operation evidently has become encapsulated and is manifest by collections of black and brown pigment. Oedematous fibrous tissue containing blood-vessels extends inward on either side across the joint surface, evidently a prolongation of the synovia. The cartilage has disappeared from the joint surface, except in a small area over the tip of the lateral condyle. Here the cartilage cells have lost their columnar arrangement. There is no evidence of regeneration of cartilage.



New cartilage on medial aspect of femur, for articulation with the dislocated patella.

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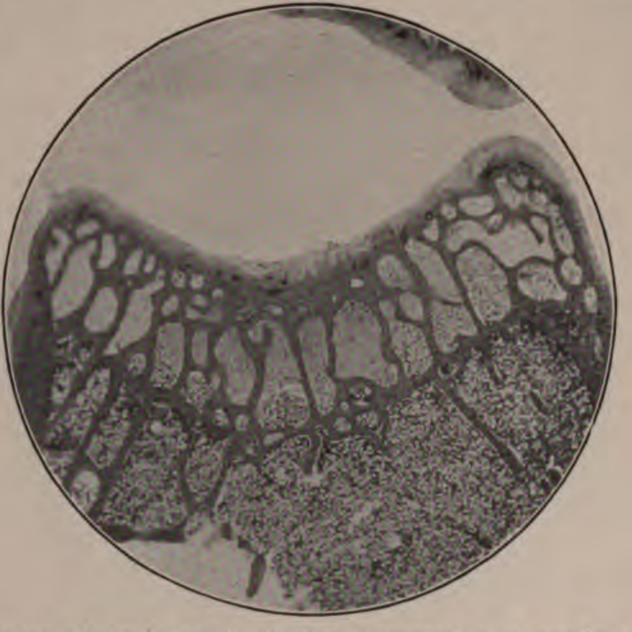

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New cartilage on medial aspect of femur, for articulation with the dislocated patella.

Killed by blow on neck. The wound has healed completely, leaving no trace. The quadriceps apparatus has slipped over the internal condyle, and this condition is evidently responsible for the limitation of extension. The patella was over the medial aspect of the femur.

Joint into 80% alcohol.

A swelling on the right side of the jaw proved to be a multilocular cyst. On opening it, a parasite identified under the microscope as a species of tapeworm was revealed inside.

Examination of Joint, Aug. 12. Joint opened by incision on the lateral aspect, reflecting the extensor apparatus to the medial side. On opening the joint the cartilage appeared irregular in texture, surface and color, but was not eroded. The patella seems to be making a new articular surface for itself on the medial aspect of the medial condyle. The site of the burn is covered with what appears to be a plug of new fibrous tissue, and this plug extends upward in the intercondylar notch to the upper portion of the joint.

On removing the plug of tissue over site of burn an excavation of about 5 mm. in diameter is revealed, occupying the entire space between the condyles. The surface of depression is roughened. The cartilage seems to have been eroded. Above this is a firm, whitish, fibrous mass overlying cartilage. The bearing surface of the medial condyle and that of the tuberosity show what appear to be beginning erosions.

HISTOLOGY.—The burned area (manifest by the collections of black and brown pigment) is occupied by a small projection or teat between the condyles. This is composed of bone in its deeper portion. Above this (superficial) are spaces containing traces of necrotic bone. The outline of the stellate bone cells can be made out. The bone injured at operation evidently has become encapsulated. Above this necrotic tissue is the pigmented area described above. Covering this is a smooth band of dense fibrous tissue, which can be traced on either side clear across the joint surface, becoming thinner and less dense toward the periphery. It expands on either side into an oedematous fibrous tissue, containing many blood-vessels. A synovial membrane covers this fibrous tissue. We interpret the teat as a collection of necrotic material in a fibrous capsule, much of which capsule is undergoing ossification. The cartilage has disappeared entirely from the joint surface, except in a small area over the tip of the lateral condyle. This is losing in places its columnar arrangement, is covered over by fibrous tissue, and is evidently ossifying from below. The marrow is pushing up into it. We regard the change at site of injury as the result of the action of the synovial membrane spreading in from the periphery. The whole con-

tour of the medial condyle is changed. Instead of being approximately a straight line, it bulges out and forms a convexity.

On the medial aspect of the specimen, a new articulation is forming. The bone is covered in places by cartilage, in places by fibro-cartilage, and these again are covered by fibrous tissue, and in some places by synovial membrane. Between this area and the tip of the condyle, beneath the surface of the bone, there is a rather large, irregular area of new-formed cartilage, which is apparently undergoing ossification. The marrow is densely cellular in the vicinity, and is pushing through the layer of cortical bone. This pushing through exists all along down the side of the condyle.

The marrow throughout the specimen is lymphoid.

The synovial membrane is villous, and the structure of the villi is fibrous, with a layer of cells on the surface. The new intercondylar synovia is oedematous.

The structure of the synovial membrane is much the same as in "arthritis deformans."

Rabbit 35, 47 days.

Young rabbit.

Feb. 19/14. Duplicate of former operations of *gouging* out a circular area about 2 or 3 mm. in diameter from the under surface of right patella. Wound sutured in two layers. Collodion.

Apr. 7. Died.

AUTOPSY, Apr. 8.—Joint appears absolutely normal. The wound has completely healed. On posterior and lateral portion of the thigh there is a collection of cheesy material, communicating with the surface and running upward over the spine down into the lateral portion of the opposite thigh. About this encapsulated cheesy material the veins are injected. Operated knee-joint opened by transverse incision; the synovia is possibly a trifle injected, but otherwise the joint generally appears normal. The operation wound on patella shows as a slightly depressed light-brown scar. Patella removed for observation and placed in Orth's fluid. The right lung seems injected. At the lower margin of the left lung is a brownish, discolored area. Cause of death probably pneumonia.

HISTOLOGY.—The wound in the cartilage is filled with fibrin which has become partly organized into fibrous tissue. Near one side of this tissue cartilage cells can be seen, and there is also a large nest of cartilage below the tissue, whose matrix is basophilic. The cartilage bordering on the hole at the side presents areas of basement substance with few cells, and on one side its cells are proliferating. There is a thin layer of bluish cartilage beneath the wound in some of the slides—zone

of provisional calcification. The marrow is lymphoid, and somewhat engorged. This is evidently a case of *new forming cartilage.*

Rabbit 36.

Young rabbit.

Feb. 19/14. Duplicate of former operations of making a circular incision about 2 or 3 mm. in diameter through the cartilage on under surface of right patella.

Oct. 7. Rabbit lost.

Rabbit 37, 138 days.

Young rabbit.

Feb. 23/14. Duplicate of operation of making circular incision 2 mm. in diameter through the cartilage on the posterior surface of the right patella. Wound sutured with chromicised catgut in two layers. Collodion.

Low-power photomicrograph. The incisions are seen to extend through the cartilage. One remains open, another appears closed at the surface and is open throughout the rest of its extent, while a third is closed throughout its whole depth. The closure is by simple apposition of the edges, and not by any active process of cartilage regeneration. The joint otherwise is normal.

July 11. Rabbit killed by blow on back of neck. Joint apparently perfectly normal. It was removed with about 3 cm. each of femur and tibia. Red marrow in femur shaft.

Joint opened. Apparently perfectly normal except for a slight injection of the synovia in the quadriceps pouch, medially, where it passed to the cartilage. The incision of patella could not be distinguished with the naked eye. The cartilage appeared perfectly normal; under a magnifying-glass it appeared superficially fissured. There were no "Randexostosen," nor any signs of abnormality about the joint.

Histology.—The cartilage throughout most of its extent appears normal. In the various sections can be seen fissures in it, perpendicular to the surface,—in some one, in some two, and in some three. One fissure (a deep one) shows the surface of the cartilage on one side slightly higher than on the other, and has its mouth plugged by what appears to be chondro-mucin, containing a few small areas of cartilage cells. Another fissure reaches only about half-way through the cartilage, and has an open mouth. Another deep one seems to have been healed near the surface by a fusion of its walls, but is open deeper in. Marrow fatty throughout. Synovia normal. No exostoses.

The overlapping borders are the circumferential ones, that is, the cuts point toward the middle of the patella.

Rabbit 38, 235 days.

Young rabbit.

Feb. 23/14. Duplicate of operation of gouging out a circular piece of cartilage about 2 mm. in diameter from the posterior surface of the patella. Wound sutured with chromicised catgut in two layers. Collodion.

Oct. 16. Rabbit, in perfect health, killed by blow on back of head. The incision has healed completely and cannot be distinguished. Joint opened by incision from above. Site of wound in patella can be barely distinguished by a slight irregularity in the cartilage, an irregularity which is not perceptible when the handle of the scalpel is passed over it. Joint otherwise is normal. No Randexostosen. No evidences of inflammation in the synovial membrane.

Histology.—The sections presumably have been taken rather high up on the wounded area, or rather low down, for the changed area in the cartilage is narrower than the actual wound. Cartilage, whose structure is irregular, has filled up the gouged area. The columnar arrangement of the cells is absent, and the ratio of cells and basement substance

mucin, broader at the surface than deeper in. Close to it on the unwounded area the cartilage cells are proliferating. The bone beneath

Low-power photomicrograph, showing production of new cartilage over wounded area. Note thickness of bone buttress under it.

the injury is denser than elsewhere. The marrow throughout the bone is practically all fatty. The synovia looks normal.

This is an example of regenerated cartilage.

Rabbit 41, 60 days.

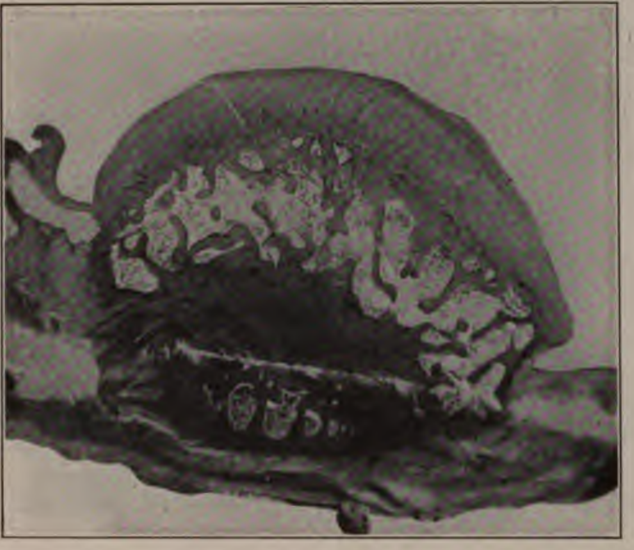
Mar. 5/14. Repetition of circular incision through cartilage on posterior surface of patella. The animal struggled a great deal while being prepared, and may have wrenched his leg.

May 5. Rabbit (in perfect health) killed by blow behind neck. Wound healed completely. The end of the femur seems enlarged, but the enlargement may be only apparent, due to the displacement of the patella inward with its tendon. Joints (knees) into 80% alcohol.

Joint examined Aug. 13. Joint opened by a lateral incision.

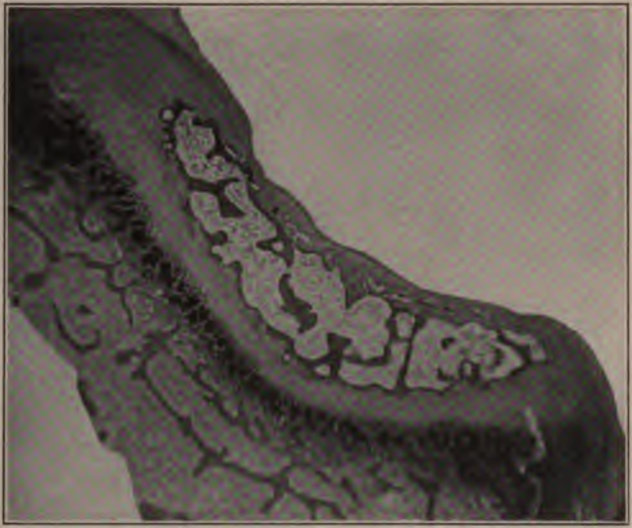
Patella dislocated medially and resting against medial aspect of medial condyle, on which it has made an articular surface, apparently covered with cartilage. Cartilage on surface of patella fairly smooth, but with an irregular, faint, curved depression.

At upper portion of joint (between the condylar eminences at their upper extremities) is an irregular erosion of the cartilage about 2 x 3

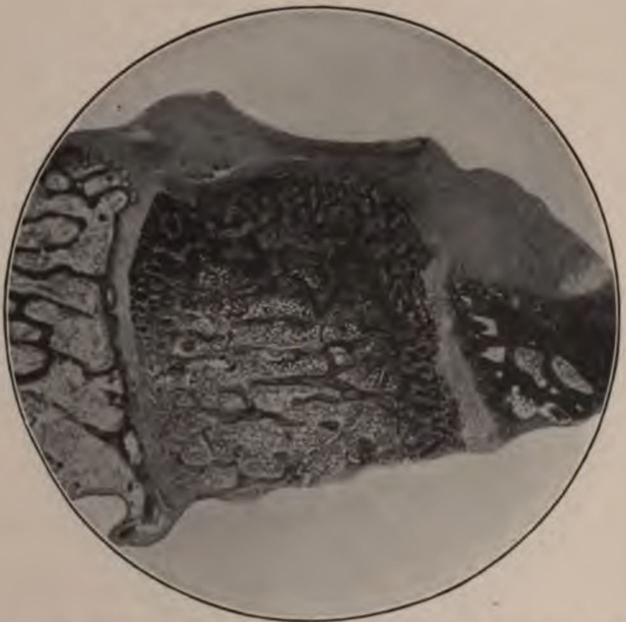


Low-power photomicrograph. The incision to the left remains open. The incision to the right, at the joint level is closed by fibrous tissue, which is continuous with the synovia. The deeper portion of the incision remains open.

High-power photomicrograph of the closed-in incision.



Low-power photomicrograph of the "eroded" area on the intercondylar notch. Note irregularity of the cartilage. The synovial membrane is creeping in over its surface.



Low-power photomicrograph showing the new articulation of the patella on the medial aspect of the femur.

mm. No border exostoses except about new place of articulation for patella.

A, Patella through injured area; *B*, Injured (eroded) area in upper part of femoral trochlea; *C*, New articular surface on medial aspect of femur.

HISTOLOGY.—*C*. The cartilage over the end of the femur is perhaps slightly thin, and fibrillated in places on its free surface. It is continuous at about the level of the ephiphyseal cartilage with fibrous tissue, representing the new articular surface. At the level of a second epiphyseal cartilage layer in the specimen, this fibrous tissue changes to fibro-cartilage, which seems to be proceeding from this second epiphyseal line.

B. A thin layer of cartilage (about half normal thickness) with irregular, wavy surface, covers the bone. This is perforated by the marrow below, which is sending prolongations up into it, and communicates with a thin layer of fibrous tissue on the surface, which looks like synovia. Where the marrow pushes up into the cartilage it is evidently building bone, for it is often surrounded by a layer of bone, and there is in the deep portion bone formation. The superficial layer of cells of the fibrous tissue at the surface of the cartilage looks like synovia, with which it is continuous at the edge of the cartilage. On both condylar ridges the cartilage is fibro-cartilage.

This slide shows a distinctly different type of disease from that described by Axhausen. Marrow is lymphoid.

A. In some slides two cuts can be identified, in others only one. *One cut* is present in all. It runs from the surface of the cartilage to the bone, and has the usual shape,—that is, at first, at an angle with the surface, and then perpendicularly. The rounded margin of the cartilage is, as usual, nearer the circumference.

The other side rises to a higher level, and at the tip contains few cells, and much basement substance. The synovia on this side is markedly proliferated, and seems to be extending out over the cartilage, but not extending as much as on the other side. A small strand of fibrous tissue runs from the bottom of the slit, through the bone, to the subjacent marrow.

The other cut. In those sections in which this is visible, it is of a greater or lesser length, but in all it is closed over at the joint surface. The overlapping border here is the one nearest the center also. The margin away from the circumference contains few cells, and much basement substance. It is prolonged upwards, passes over the cut to close

it in, and is covered above by a layer of fibrous tissue, which passes in from the synovia over the surface, and is continued for some distance beyond the cut. At one spot the fibrous tissue at the surface is thrown into folds or villi, like those of a synovial membrane. In one section there is, at the site of the cut, close to the surface, what appears to be a small area of calcification.

The cartilage between this slit and the circumference presents peculiar features. Superficial to the layer of cartilage is a narrow area (strip) in which are large quantities of fibroblasts (some of them in pairs) surrounded by a homogeneous substance which is continuous with the columns of chondro-mucin in the cartilage below. This substance stains deeper as it approaches the cartilage below. The whole layer gives the impression of fibrous tissue being converted into cartilage. This layer is quite apparent near the cut, but shades off, and disappears near the circumference.

Above this layer is fibrous tissue in a fairly thick layer, which looks like synovial membrane, and is continuous with the synovial membrane at the side. The arrangement of the cells throughout the cartilage is columnar.

The junction of cartilage and subjacent bone is not in a regular line as usual, but is very irregular, and not clearly defined. Bone and cartilage shade into each other and are prolonged into each other. In places under the entire extent of the cartilage, the marrow is pushing up through in small fingers.

Marrow throughout is lymphoid.

This case again shows the change of synovial membrane into cartilage, wrought by pressure upon it.

Rabbit 42, 27 days.

Mar. 13/14. Repetition of *cauterizing* a 3 mm. area in cartilage, intracondylar, on anterior surface of femur. The burning was poorly done, searing cartilage above spot of intended damage. Cautery at dull red-heat.

Apr. 9. Died.

AUTOPSY, Apr. 11.—This rabbit, like most of the others which have died, evidently had a severe diarrhoea.

The operation wound had healed completely. Joint opened. Wound in cartilage identified. The joint appears quite normal except for a slight injection of the synovia near its line of reflection.

No cause of death found in abdomen or chest.

Lower end of femur into HNO_3, 5; alcohol (95%), 95.

HISTOLOGY.—The cartilage over both condylar ridges is normal. The groove between them where the cartilage was burned, is occupied by a layer of hyaline material, making the contour of the intercondylar

The area of the burned cartilage between the condylar eminences is occupied by a homogeneous layer of hyaline material.

groove normal. This hyaline material has at its middle, below the surface, a broad group of cells which stain poorly, and evidently are degenerating. Directly beneath this group of cells, fibroblasts can be seen making their way into the hyaline material from the marrow below.

Rabbit 43, 24 days.

Mar. 13/14. Repetition of cauterizing operation by dull-red actual cautery, on anterior intercondylar surface of femur.

Apr. 6. Death.

The thigh is drawn up slightly, and complete extension is not possible in knee. Otherwise knee appears quite normal. There is a large open wound on external aspect of lower part of right thigh, laying bare the bone, but apparently not involving the joint. The operation wound has healed.

The joint was opened by transverse incision. The synovia appeared normal, and the other joint tissues, except for the following peculiarities. The patella was displaced inward and was forming a new hollow of articulation on the medial aspect of the medial condyle—as if it had not been replaced after the operation. Below it (distal) is an erosion of

it in, and is covered above by a layer of fibrous tissue, which passes in from the synovia over the surface, and is continued for some distance beyond the cut. At one spot the fibrous tissue at the surface is thrown into folds or villi, like those of a synovial membrane. In one section there is, at the site of the cut, close to the surface, what appears to be a small area of calcification.

The cartilage between this slit and the circumference presents peculiar features. Superficial to the layer of cartilage is a narrow area (strip) in which are large quantities of fibroblasts (some of them in pairs) surrounded by a homogeneous substance which is continuous with the columns of chondro-mucin in the cartilage below. This substance stains deeper as it approaches the cartilage below. The whole layer gives the impression of fibrous tissue being converted into cartilage. This layer is quite apparent near the cut, but shades off, and disappears near the circumference.

Above this layer is fibrous tissue in a fairly thick layer, which looks like synovial membrane, and is continuous with the synovial membrane at the side. The arrangement of the cells throughout the cartilage is columnar.

The junction of cartilage and subjacent bone is not in a regular line as usual, but is very irregular, and not clearly defined. Bone and cartilage shade into each other and are prolonged into each other. In places under the entire extent of the cartilage, the marrow is pushing up through in small fingers.

Marrow throughout is lymphoid.

This case again shows the change of synovial membrane into cartilage, wrought by pressure upon it.

Rabbit 42, 27 days.

Mar. 13/14. Repetition of *cauterizing* a 3 mm. area in cartilage, intracondylar, on anterior surface of femur. The burning was poorly done, searing cartilage above spot of intended damage. Cautery at dull red-heat.

Apr. 9. Died.

AUTOPSY, Apr. 11.—This rabbit, like most of the others which have died, evidently had a severe diarrhoea.

The operation wound had healed completely. Joint opened. Wound in cartilage identified. The joint appears quite normal except for a slight injection of the synovia near its line of reflection.

No cause of death found in abdomen or chest.

Lower end of femur into HNO_3, 5; alcohol (95%), 95.

HISTOLOGY.—The cartilage over both condylar ridges is normal. The groove between them where the cartilage was burned, is occupied by a layer of hyaline material, making the contour of the intercondylar

The area of the burned cartilage between the condylar eminences is occupied by a homogeneous layer of hyaline material.

groove normal. This hyaline material has at its middle, below the surface, a broad group of cells which stain poorly, and evidently are degenerating. Directly beneath this group of cells, fibroblasts can be seen making their way into the hyaline material from the marrow below.

Rabbit 43, 24 days.

Mar. 13/14. Repetition of cauterizing operation by dull-red actual cautery, on anterior intercondylar surface of femur.

Apr. 6. Death.

The thigh is drawn up slightly, and complete extension is not possible in knee. Otherwise knee appears quite normal. There is a large open wound on external aspect of lower part of right thigh, laying bare the bone, but apparently not involving the joint. The operation wound has healed.

The joint was opened by transverse incision. The synovia appeared normal, and the other joint tissues, except for the following peculiarities. The patella was displaced inward and was forming a new hollow of articulation on the medial aspect of the medial condyle—as if it had not been replaced after the operation. Below it (distal) is an erosion of

cartilage, whose borders are quite regular. The site of the burn on the femur is evident by a reddened, depressed area whose borders are rather sloping and smooth, and larger than the original burn, giving an appearance similar to that of a healing leg ulcer.

Whole lower end of femur into Orth's solution.

Cause of death not apparent from autopsy. Probably death was caused by the thigh wound.

HISTOLOGY.—Site of burn identified as a shallow depression, going down to the subjacent bone buttress, and partially filled with new fibrous tissue which communicates with marrow below. The fibrous tissue runs out on the surface of the cartilage for some distance, and underneath it the cartilage is degenerated in places. The marrow is hyperaemic, but otherwise normal. No evidence of border exostoses.

CONCLUSION

A cut in the cartilage of the patella may persist indefinitely, or it may be closed in, usually at or near the surface. When closed in partially or completely, the closing in is usually not by a repair, a union, an active process, but simply by a pressing together of the sides of the cut.

A cut in the cartilage of the patella occasions no change in cartilage at a distance, or in the bone beneath, or in the synovia, in the majority of instances. In a few cases where the cut was near the periphery, the synovia spread in over the cartilage apparently in an effort to repair the damage, and in one case (rabbit 41) actually did close in the cut at the surface. Otherwise the synovia was not affected.

Usually the cut runs obliquely near the surface, then turns and runs more perpendicularly, following the known direction of the fibers of the basement substance of the cartilage.

A small hole gouged out of the patellar cartilage usually fills up with new cartilage. In one of our cases the active agent in this process seems to be the synovial membrane which spreads in from the side; in the others the active agent in the production of the new cartilage cannot be determined, but the cartilage appears to be formed from a plug of fibrous tissue which fills in the hole (*vide* rabbit 35).

In some cases the bone trabeculae have been thickened under the site of the injury. In one the bony buttress was markedly thickened under the injured cartilage, and helped to fill up the defect in it.

A hole burned in the cartilage of the intercondylar groove on the front of the femur persists indefinitely, and rarely fills in (*vide* rabbit 28). A gap almost always remains, whose base is formed by bare bone.

If the burn goes through the subjacent bone, the hole becomes plugged with fibrous tissue, which later turns to bone, and shuts off the marrow from the joint cavity; but the bony layer is below the level of the original bone. Cartilage may appear in the fibrous tissue in the marrow, and take part in the bone formation.

The cartilage around the margin of the burn loses its cells and persists, even after 360 days, as a depressed area, or halo, over which the synovia never extends.

The marrow immediately beneath the burn sometimes becomes fatty in a small area. No constant change has been determined in the marrow.

In only one or two instances in the three sets of experiments were any adhesions formed in the joint, and those only in the burn cases.

Synovial membrane, when exposed to pressure between two bones, transforms into cartilage, usually fibro-cartilage. This is plainly seen in several cases, in which luxation of the patella took place, and new cartilage formed on the side of the condyle.

In one or two of our animals, in which the patella was permanently dislocated, a rudimentary patella of fibrous tissue formed in the quadriceps tendon, at a spot corresponding to the former location of the original patella.

In one or two instances a fibro-cartilaginous plate formed on the side of the patella, but we attribute this to injury done at the time of the operation to the synovial membrane in the immediate vicinity of the bone. The incision was made in some cases very close to the border of the patella.

In none of the three series was any constant change noted in the bone, cartilage or synovial membrane at a distance from the site of operation. No "arthritis deformans," no "Randexostosen," no lipping was observed. Where general joint changes were observed they were often of an entirely different type than those of what Axhausen considers arthritis deformans.

The power of regeneration of cartilage which has been scraped off, as compared with that of cartilage which has been burned off, is noticeable. One might infer that the smaller regenerative power of the latter was due to the damage to the subjacent bone and marrow, but a later series of experiments contradicts this.

The so-called osteoclasts, giant cells in Howship's lacunae, generally considered as an evidence of rarefying ostitis, were conspicuous by their absence, and, basing our opinion on this series, as well as upon other experimental and pathological work, we are sceptical of the correctness of this interpretation of the role of these cells.

II.

REMOVAL OF A WIDE PIECE OF CARTILAGE FROM THE INTERCONDYLAR GROOVE OF THE FEMUR.

As a sequel to the former series of experiments on rabbits' cartilage the following series was undertaken, to determine more definitely:

1. The reaction of the joint tissues to cartilage injury.

2. Whether or not cartilage was regenerated after its removal.

We were interested also to find out the truth of Axhausen's conclusions that an injury to the joint cartilage caused the production of "border exostoses" (Randexostosen) and the phenomena of "arthritis deformans."

In the majority of cases, young rabbits were taken. The animals were anaesthetized with ether, the skin over the right knee was shaved and disinfected with soap and water, alcohol, and bichloride of mercury. The incision was a longitudinal one, medial to the patella. The patella was drawn aside, and the cartilage was removed with a scalpel, from the intercondylar region, over an area about 5 x 10 mm., with the long diameter longitudinally. This included all the cartilage between the condylar ridges for a distance of 1 cm., and part of the cartilage also from the condylar eminences. Care was observed to damage the other joint tissues as little as possible. The capsule was then sutured carefully, and the wound was dressed with collodion. The animals died or were killed at intervals from 5 to 258 days after operation.

The bone sections were fixed and dehydrated for the most part in alcohol, decalcified with 5% or 10% nitric acid, washed for a very short time in water, run up through the alcohols and ether, imbedded in celloidin, and stained with haematoxylin and eosin and by the van Gieson method.

Rabbit 51, 59 days.

Beginning a series in which the cartilage was scraped away between the two condylar ridges on the front of the femur, with a scalpel.

Aug. 13/14. Right knee. Usual preparation.

Incision through muscle medially to patella. Patella drawn laterally. Cartilage down to bone scraped away over area of about 4 x 7 mm., long diameter longitudinally, from front of femur, between the condylar eminences. Wound sutured in two layers. Catgut, collodion.

Oct. 12. Rabbit died yesterday.

AUTOPSY.—The knee was surrounded by a lobulated, obscurely fluctuating mass. This was dissected off as carefully as possible, but was punctured several times. It contained the cheesy material so common in rabbits (pus infection). The collection evidently came from the knee. The joint was full of the same material. The cartilages were roughened and the joint was badly disorganized. Lower end of femur and patella into alcohol.

Oct. 19. Section of femur into HNO_3, 10%. Patella also.

HISTOLOGY.—Typical acute osteomyelitis and synovitis.

Rabbit 52, 258 days.

Aug. 13/14. The rabbit was rather young. Usual preparation. Right knee.

Incision through muscle medially to patella. Patella drawn laterally. Cartilage scraped away over area of about 4 x 8 mm. (long diameter longitudinally) from in front of femur, taking off everything between the two lateral eminences. Wound sutured with catgut in two layers. Collodion.

Apr. 28/15. Adult healthy rabbit, killed by blow on back of neck. Freely movable joint, opened from above. Denuded area recognized

Low-power photomicrograph showing bare bone all across the intercondylar groove. One of the few examples of "border exostoses" in our series.

as a slightly roughened, depressed area, with bottom composed of bone. There is a small "gouging out" of the medial condylar ridge at about the lower level of the denuded area. Below this the ridge appears somewhat broadened. Patella normal. Synovia somewhat thickened and villous.

A, Cross-section of denuded area. *C*, Thickened synovia.

HISTOLOGY.—*A*. The denuded area is manifest as bare bone, immediately under which the marrow is fibrous. The cartilage on the condylar eminences is irregular in its structure. Over one of the eminences fibrous tissue, continuous with the synovia, seems to be spreading. This lateral eminence is decidedly broader than the other, and the breadth is caused by bone formation, on the tip of the lateral aspect of the condyle, apparently made from fibrous tissue. There is no sign of new formation of cartilage over the denuded area between the ridges.

B. The synovial membrane in places is very fatty, in others it consists of dense fibrous tissue. It is villous, but at the surface it has a normal appearance, with a thin sprinkling of cells.

Rabbit 53, 48 days.

Aug. 13/14. Usual preparation.

Incision through muscle medially to right patella. Patella displaced laterally. Cartilage scraped away over area of about 4 x 9 mm., long diameter longitudinally, with scalpel, from the groove on the front of the femur. Wound sutured in two layers with catgut. Collodion.

Oct. 1. Rabbit died last night.

AUTOPSY.—External wound healed, and not identified. The situation of the wound in the capsule could be told by a small irregularity, an accumulation of what appeared to be fat. The wound in the capsule had not healed smoothly,—in other words, the apposition was not nice. Joint opened. The synovia is injected. The wound in the cartilage is identified easily. *At the side of the patella,* immediately adjacent to the capsular wound, is a small spur, looking as if it corresponded to the poorly united wound in the capsule.

HISTOLOGY.—*Patella.*—The spur is seen to consist of bone whose trabeculae are continuous with those of the patella. This bone is covered by a layer of fibrous tissue, whose deeper portion appears to be undergoing transformation into cartilage. The fibrous tissue is covered

Low-power photomicrograph. Femur: The surface shows bare bone, with new osteoid tissue. No formation of new cartilage. The bone trabeculae beneath are thickened, and the marrow spaces are filled, to a great extent, by fibrous tissue, which is undergoing transformation into bone. The marrow is hyperaemic. The cartilage over the condylar ridges is normal, and the step between it and the wounded area has been smoothly rounded off. No evidence of "Randexostosen." No evidence of "arthritis deformans."

High-power photomicrograph of joint surface.

partly by synovial membrane, and is continuous with the cartilage of the patella, the line of demarcation being abrupt.

Femur.—Denuded area recognized. Its surface shows bare bone, and no formation of new cartilage. The bone trabeculae beneath are thickened and the marrow spaces filled up to a great extent by fibrous tissue, undergoing transformation into bone. Farther from the joint the marrow is engorged with blood and contains much fibrinous exudate.

The cartilage over one condylar ridge is normal, and the step between it and the wounded area has been smoothly but sharply rounded off. From the other condylar ridge the cartilage has been removed, and no sign of regeneration is observed, though possibly the synovia extends a little farther up the side of the ridge than usual. No evidence of any "border exostoses." The synovial membrane is thickened and oedematous. The epiphyseal cartilage is present.

Rabbit 54, 172 days.

Aug. 14/14. Rather young animal. Usual preparation.

Incision through muscle just medially to patella. Patella displaced laterally. Cartilage scraped away with scalpel from the intercondylar groove on front of femur, its entire width, about 5 x 10 mm., long diameter longitudinally. Wound sutured in two layers with chromic catgut. Collodion.

Feb. 2/15. Rabbit died.

Feb. 3. Joint laid open from above. Denuded area identified as a slightly depressed, roughened area not covered by cartilage. The synovia is injected. There are no "border exostoses."

HISTOLOGY.—The cartilage over one condylar eminence is present, but is thinner than normal and is irregular in structure. Over the other condyle the cartilage is mostly absent. The synovial membrane extends well up the side of both ridges. The denuded area is still bare of cartilage, except occasionally for small areas of transitional tissue (bone and cartilage) lying in the bone, flush with the surface. No sign of any new cartilage production between the ridges, except for one or two small pieces. The synovial membrane is creeping up the side of the condyles in the form of a perichondrium.

The synovial membrane is normal. The marrow near the joint is oedematous lymphoid, and somewhat engorged. Deeper in, the marrow is lymphoid, and the engorgement is much greater. No epiphyseal line is present. The trabeculae are about normal in number and thickness.

Rabbit 55, 220 days.

Aug. 14/14. Rather young animal. Usual preparation.

Usual incision through muscle just medially to patella. Patella displaced laterally. Cartilage scraped away with scalpel from the intercondylar groove on front of femur, entire width, about 5 x 10 mm., long diameter longitudinally. Wound sutured with chromic catgut in two layers. Collodion.

Mar. 23/15. Rabbit died last night.

AUTOPSY.—Hair has grown over wound. Joint apparently normal. Joint opened from above. Wound in cartilage identified. It feels rough to the handle of the scalpel, and appears to be bare bone with small islands of cartilage. The condylar ridges are roughened and irregular, and there is a large erosion on the medial condyle. The head of the tibia is normal. Patella on each side, where it articulates with the condylar ridges, has a cartilaginous or bony prolongation, as if caused by the rough surface of the condylar ridges. The marrow in the femur is haemorrhagic.

A, Femur with operated area. *B*, Patella.

HISTOLOGY.—*B*. On one side of the patella the cartilaginous prolongation noted in the gross inspection is hardly distinguishable, except that the fibrous joint capsule is very thick, and appears to be undergoing transformation into cartilage in one area. The other side of the patella is continued to form a spur of bone well covered by cartilage, and this again by fibrous tissue. The spur has been built up apparently in the fibrous capsule at the side of the bone, for the cartilage over the bone in the spur does not border on the joint, except at the base of the spur. The marrow in the spur is engorged. The line of demarcation between the new cartilage and the old is very sharp and distinct. This patella presents a "border exostosis" of Axhausen, but no signs of arthritis deformans.

A. The cartilage is present over the condylar ridges, but is irregular in the arrangement of its cells. The synovial membrane is creeping up the side of the ridges to form a distinct perichondrium. The cells of the cartilage are grouped, and certain areas contain no cells. The operated area presents a strip of fairly new cartilage at its middle, and on each side of this a strip of bare bone. The new cartilage seems to have developed at the expense of the subjacent bone,—that is, its surface is nearly on the level of the adjacent bare bone. The trabeculae under the new cartilage are thickened. Fragments of necrotic bone caught in the meshes of fibrin lie in the joint.

partly by synovial membrane, and is continuous with the cartilage of the patella, the line of demarcation being abrupt.

Femur.—Denuded area recognized. Its surface shows bare bone, and no formation of new cartilage. The bone trabeculae beneath are thickened and the marrow spaces filled up to a great extent by fibrous tissue, undergoing transformation into bone. Farther from the joint the marrow is engorged with blood and contains much fibrinous exudate.

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Rabbit 54, 172 days.

Aug. 14/14. Rather young animal. Usual preparation.

Incision through muscle just medially to patella. Patella displaced laterally. Cartilage scraped away with scalpel from the intercondylar groove on front of femur, its entire width, about 5 x 10 mm., long diameter longitudinally. Wound sutured in two layers with chromic catgut. Collodion.

Feb. 2/15. Rabbit died.

Feb. 3. Joint laid open from above. Denuded area identified as a slightly depressed, roughened area not covered by cartilage. The synovia is injected. There are no "border exostoses."

Histology.—The cartilage over one condylar eminence is present, but is thinner than normal and is irregular in structure. Over the other condyle the cartilage is mostly absent. The synovial membrane extends well up the side of both ridges. The denuded area is still bare of cartilage, except occasionally for small areas of transitional tissue (bone and cartilage) lying in the bone, flush with the surface. No sign of any new cartilage production between the ridges, except for one or two small pieces. The synovial membrane is creeping up the side of the condyles in the form of a perichondrium.

The synovial membrane is normal. The marrow near the joint is oedematous lymphoid, and somewhat engorged. Deeper in, the marrow is lymphoid, and the engorgement is much greater. No epiphyseal line is present. The trabeculae are about normal in number and thickness.

Rabbit 55, 220 days.

Aug. 14/14. Rather young animal. Usual preparation.

Usual incision through muscle just medially to patella. Patella displaced laterally. Cartilage scraped away with scalpel from the intercondylar groove on front of femur, entire width, about 5 x 10 mm., long diameter longitudinally. Wound sutured with chromic catgut in two layers. Collodion.

Mar. 23/15. Rabbit died last night.

AUTOPSY.—Hair has grown over wound. Joint apparently normal. Joint opened from above. Wound in cartilage identified. It feels rough to the handle of the scalpel, and appears to be bare bone with small islands of cartilage. The condylar ridges are roughened and irregular, and there is a large erosion on the medial condyle. The head of the tibia is normal. Patella on each side, where it articulates with the condylar ridges, has a cartilaginous or bony prolongation, as if caused by the rough surface of the condylar ridges. The marrow in the femur is haemorrhagic.

A, Femur with operated area. *B*, Patella.

HISTOLOGY.—*B*. On one side of the patella the cartilaginous prolongation noted in the gross inspection is hardly distinguishable, except that the fibrous joint capsule is very thick, and appears to be undergoing transformation into cartilage in one area. The other side of the patella is continued to form a spur of bone well covered by cartilage, and this again by fibrous tissue. The spur has been built up apparently in the fibrous capsule at the side of the bone, for the cartilage over the bone in the spur does not border on the joint, except at the base of the spur. The marrow in the spur is engorged. The line of demarcation between the new cartilage and the old is very sharp and distinct. This patella presents a "border exostosis" of Axhausen, but no signs of arthritis deformans.

A. The cartilage is present over the condylar ridges, but is irregular in the arrangement of its cells. The synovial membrane is creeping up the side of the ridges to form a distinct perichondrium. The cells of the cartilage are grouped, and certain areas contain no cells. The operated area presents a strip of fairly new cartilage at its middle, and on each side of this a strip of bare bone. The new cartilage seems to have developed at the expense of the subjacent bone,—that is, its surface is nearly on the level of the adjacent bare bone. The trabeculae under the new cartilage are thickened. Fragments of necrotic bone caught in the meshes of fibrin lie in the joint.

The marrow is engorged, the blood sinuses are greatly distended. The synovial membrane appears possibly a trifle thickened.

No epiphyseal line is present.

Rabbit 57, 100 days.

Aug. 14/14. Rather young animal. Right knee.

Usual incision through muscle just medially to patella. Patella displaced laterally. Cartilage scraped away with scalpel from the intercondylar groove on the front of the femur. Area of denudation about 5 x 10 mm., with its long diameter directed longitudinally. Wound sutured with chromic catgut in two layers. Collodion.

Nov. 22. Rabbit died.

AUTOPSY.—The joint from the outside is apparently normal. Joint opened from above. The synovial membrane apparently has undergone a villous change. The denuded area of femur identified. Its surface is still rough. On the medial aspect of the medial condyle is what appears to be an erosion—a loss of substance in the bone.

A, Denuded area.

HISTOLOGY.—The denuded area does not extend clear across the intercondylar groove, but on one side the bone is covered by cartilage continuous with the condylar cartilage for a distance of at least one-third that between the condyles. For some distance from the condyle, this cartilage looks fairly normal; then it suddenly changes its structure, and becomes markedly irregular in outline. Its cells are arranged in groups of various sizes, separated by masses of basement substance. Its surface is indented. This thin, irregular layer gradually ceases, and the bone is bare for some distance. The other condyle is mostly bare. The removed cartilage has not been replaced here, and up the side of this condyle the synovia is extending.

Beneath the wounded area the bone trabeculae are thickened.

The synovia appears normal, and there are no evidences of extensive bone and cartilage changes set in play by the injury other than the thickening of the trabeculae.

The epiphyseal line is present.

This is an example of regeneration of a part of the destroyed cartilage.

Rabbit 58, 252 days.

Aug. 17/14. Rather young animal. Right knee.

Incision along medial side of patella and tendon. Joint opened.

Patella displaced laterally. Entire cartilage removed from trochlear surface of femur between the condylar ridges. Capsule sutured with chromic, skin with plain gut. Collodion.

Autopsy.—Apr. 26/15. Healthy rabbit, killed by blow on back of head. Joint normal. Movements free. Joint opened from above.

Denuded area identified. It is slightly depressed and is slightly rough to handle of scalpel. Medial condylar ridge at the level of the injury has been (apparently) eaten away so as to give a concave appearance to ridge when viewed from in front. Below this loss the condylar ridge is more prominent (border exostosis?).

Patella, articular surface normal. What appears to be the development of new cartilage has taken place at the sides of the patella over the condylar ridges, better marked over the medial than over the lateral condyle. The synovial membrane is normal.

A, Section through femur in region of erosion—80% alcohol.

B, Section through femur in region of exostosis—80% alcohol.

C, Patella.

Histology.—*B*. The cartilage over the lateral eminence is thin, and apparently is being transformed into bone. The medial eminence is broader than normal, and is prolonged medially so as to give the effect of the exostosis noted in the gross examination. It is covered with cartilage, some normal, some apparently undergoing ossification. This cartilage varies in thickness, but has, over the end of the bone, a fairly smooth surface. Over the exostosis at the side it presents several teats. This exostosis resembles those found in "arthritis deformans" possibly, but the remainder of the joint surface presents an entirely different appearance.

The denuded area shows partly as bare bone, partly as bone covered over by a thin layer of fibrous tissue, which apparently is being transformed into bone, partly by a tissue transitional between bone and cartilage. No new growth of cartilage has taken place on the denuded area. The cartilage cells were probably in cartilage left by the gouge. The marrow is somewhat fatty near the joint, at about the middle of the specimen, lymphoid elsewhere.

A. Both eminences are covered by a thin layer of cartilage, whose cells have the arrangement in large groups, so frequently seen in these cases. The space between them shows bare bone, and a tissue transitional between cartilage and fibrous tissue. Close to the medial condyle a large cavity is present in the joint end, lined by fibrous tissue, backed up by bone trabeculae. A bulging out of the medial aspect of the em-

inence gives it the "hook" appearance noted above. The synovial membrane extends very far up the side of each condylar eminence. The appearance of this slide is more characteristic of Type I * than of Type II. No epiphyseal cartilage is present.

C. On one side of the patella the cartilage is prolonged in a triangular mass which tapers slowly to a pointed extremity. The capsule in the vicinity seems to be undergoing transformation into cartilage. On the other side (evidently the medial) the patella is prolonged into a distinct bony and cartilaginous spur. The cartilage over the spur has a decidedly irregular surface. Streamers or tatters run from it. Its cells are arranged in large groups, and as the end of the spur is approached the cartilaginous layer at the surface shades into fibrous tissue, and the dividing line between the bone and fibrous tissue at the spur end is hard to establish. Apparently the spur has been formed, and was being formed by the change of the capsule at the side of the patella, into bone and cartilage. This appears to be a typical "border exostosis," as described by Axhausen.

Rabbit 59, 165 days.

Aug. 17/14. Rather young animal. Right knee.

Incision along medial side of patella and tendon. Joint opened. Patella displaced laterally. Entire cartilage removed from trochlear surface of the femur, between the condylar ridges, with scalpel. Ligament sutured with chromicized catgut. Skin sutured with plain gut. Collodion.

Jan. 30/15. Rabbit died last night. Joint from outside appears normal.

AUTOPSY.—Joint opened from above. Wounded area identified. It is somewhat rough, and at its lower portion is a small deeper excavation about 2 x 3 mm. in diameter (*A*). In the upper part of the joint on the front of the femur and contiguous with the damaged area is a deep excavation through the cartilage down into spongy bone beneath (*B*). This excavation (*B*) lies directly under the patella when the leg is in

* By Type I we mean the hypertrophied synovial membrane, the atrophic changes in the bone, and the erosion and perforation of the cartilage, such as are ordinarily found in tuberculosis, gonorrheal joints, pus joints and the chronic arthritides variously known as "infectious" chronic arthritis, atrophic arthritis (Goldthwait), rheumatoid arthritis (English), and the proliferative form (Nichols and Richardson). The appearance of this joint indicates that changes of both types may be found in one joint.

full extension. The patella (*C*) appears to be broader than normal, and to be provided at its borders with "border exostoses," though this is not certain, and can only be determined under the microscope. Head of the tibia is normal. *D,* Denuded area between excavations.

The rabbit is in very poor condition. It is emaciated, and its intestines are almost empty. The liver presents many small nodules. The wall of the stomach near the pylorus is thickened and hard. Remnants of epiphyseal line are present.

HISTOLOGY, *D*. The cartilage over one condylar eminence has changed almost entirely to fibrous connective tissue. Over the other eminence the cartilage is present, but the cells are arranged in irregular groups, and on the lateral aspect of the eminence the change to fibrous connective tissue is manifest,—that is, the synovia is creeping over the eminence, in the form of a perichondrium. The denuded area shows two small strips of bare bone, and between them a rather extensive strip of cartilage, fairly normal, except that it is rather thin. This cartilage apparently is new cartilage grown over part of the site of operation.

C. The surface of the patellar cartilage is somewhat rough. The cartilage appears to be degenerating. Areas of basement substance without cells are seen with an arrangement perpendicular to the surface, and these give the cartilage a striated appearance. The marrow is lymphoid. The synovia is normal. There is no distinct evidence of the spurs mentioned in the gross inspection, but the cartilage on one side of the slide is a little knob-like.

B. The cartilage is absent from the entire joint surface, including the condylar ridges, and has been replaced by fibrous tissue. Synovial membrane covers the ridges. Underneath the fibrous tissue is a layer of bone, and no communication exists between the joint cavity and the marrow, except that the fibrous tissue covering the bone is continuous with the marrow tissue. The whole bone end is gouged out, throwing the two condylar ridges into great prominence; but two small elevations are present on the intercondylar surface, whose summits probably represent the level of the original joint line. In the joint cavity, over the denuded area and by the side of the condyle, are collections of small fragments of bone enmeshed in fibrous tissue, having the appearance of synovial membrane at the surface. The connection of some of the collections with the synovial membrane can be demonstrated. The marrow is engorged and lymphoid.

The synovia is thickened, engorged and villous, and the fibrous tissue over the joint is evidently the result of its extension inward.

A. The cartilage over the condylar eminences is present, but its cells over one eminence show a decided tendency to arrangement in large groups. Over the other eminence the cartilage is thinned and is partly replaced by fibrous tissue. A deep cleft is present in one cartilage (the first), going down to the bone. The joint surface between the condyles is extremely irregular, and is composed mostly of cartilage of varying thickness. The excavation noted in the gross inspection is fairly deep. Its bottom is composed of a thin layer of bone covered by a tissue which appears transitional between bone and cartilage. At one side of the excavation is a small elevation covered by cartilage, and beside this another smaller excavation lined by degenerating cartilage. The subcartilaginous layer of bone is rather thin all across the specimen, and the trabeculae are thin and scant. The marrow is lymphoid. Remnants of the epiphyseal line are present. Very little cartilage is present on the side of the condyles.

This appears to be an example of new production of cartilage, with a type of joint changes quite different from those of "arthritis deformans."

Rabbit 60, 82 days.

Aug. 17/14. Rather young rabbit. Right knee.

Incision along medial side of patella and tendon. Joint opened. Patella displaced laterally. Entire cartilage removed (by knife) from trochlear surface of femur between the condylar ridges (area 5 x 10 mm.). Aponeurosis sutured with chromicized gut; skin sutured with plain gut. Collodion.

Nov. 7. Animal in convulsions. Killed.

Autopsy held on Nov. 7 at 2 p.m. Observations: Discharge of a purulent mucus from nose. A rounded swelling was present in the occipital region at the base of the skull. This swelling was formed by a collection of cheesy pus-like material. The vessels of the brain were engorged, and the pus-like material had begun to work its way onward along the vertebral arteries, especially on the right side. Joint put into 80% alcohol.

Nov. 12. Examination of joint. Joint opened from above. Denuded area roughened. No other evidences of joint abnormality.

Histology.—The injured area is without cartilage, except for two or three very small pieces, which look as if they had been left behind by the knife. The marrow in the immediate vicinity of the joint consists largely of fibrous tissue, which is undergoing transformation into bone, making the bone trabeculae much thicker than normal, so that

the bone is quite dense near the joint. Beneath the fibrous marrow the marrow is quite fatty. The cartilage over the condylar eminences is irregular in structure, and has not regenerated where it was removed. It presents the usual appearance of grouping of cells where it is present. The epiphyseal line is present.

Rabbit 61, 5 days.

Aug. 17/14. Rather young animal. Right knee.

Incision along medial side of patella and tendon. Joint opened. Patella displaced laterally. Entire cartilage removed with scalpel from trochlea of femur between the condylar eminences, area 5 x 10 mm. Wound sutured in two layers. Collodion.

Aug. 22. Died.

AUTOPSY, Aug. 24. The wound is evidently infected. Thigh is drawn up against abdomen in flexion. Leg flexed on thigh. Superficial veins over anterior and medial aspect of thigh and leg are injected. Some injection also of lateral veins. Beneath the fascia on anterior and medial aspect of thigh is a yellowish, purulent exudate. Over the muscle are flakes of fibrin. The vessels of the underlying muscles are injected. The knee-joint is apparently not involved. Joint removed. Cause of death could not be determined; probably septicaemia.

Aug. 24. Joint opened by lateral incision. It contains no exudate. The synovia is injected and succulent. Small blood-clot along line of incision on medial aspect. Joint put in formaldehyde solution, 3%.

Aug. 26. Transverse section of bone, made through denuded area on trochlear surface of femur. Specimen placed in 5% HNO_3.

HISTOLOGY.—The cartilage has been scraped off almost entirely from ridge to ridge. Here and there are fragments of it still clinging to the bed. The marrow immediately underneath has undergone a fibrous change. All the marrow is deeply congested. The condylar eminences are also badly damaged as to their cartilage, and at the side of the bone the cartilage has a distinct perichondrium, which is continuous with the synovial membrane. Epiphyseal cartilage present.

Rabbit 62, 38 days.

Aug. 17/14. Rather young animal. Right knee.

Incision along medial side of patella and tendon. Joint opened. Patella displaced laterally. Entire cartilage removed with scalpel from trochlea of femur between the condylar eminences, 5 x 10 mm. (long diameter longitudinally). Wound sutured with two layers of catgut. Collodion.

Sept. 24. Killed by blow on back of neck. Animal used legs normally. Wound healed. Over the site of incision in capsule is a mass of what appears to be fat (*A*). On attempting to dissect it away, the capsule was opened.

Joint opened from the lateral aspect. It presents a normal appearance. The synovia is pale and glistening. One or two small pieces of what appear to be cartilage were found loose in the joint (*B*).

The denuded intercondylar area was identified. It is rough to the handle of the scalpel. Cross-section of femur at site of denuding, so

Low-power photomicrograph.

that any section cannot fail to include the damaged area (*C*). All put into alcohol.

HISTOLOGY.—*A*. The section shows well-encapsulated areas of leucocytes, endothelial, lymphocytic, and a few polymorphs. Several giant cells. The fibrous tissue about the aggregations is very dense.

C. A thin layer of osteoid tissue of about one-half the normal thickness covers the operated area. In it, and in the bone directly beneath it, are engorged blood-vessels. The cells in this layer have a tendency to the usual columnar arrangement of cartilage, but there is more intercellular substance than normal. The condylar eminences have been damaged also, and on the lateral aspect of the condyles the synovial membrane is creeping over, forming a distinct perichondrium. This fibrous perichondrium contains blood-vessels. The marrow is lymphoid.

B. Small pieces of cartilage, which stain well. One of them is at-

tached to what appears to be thickened synovial membrane. The epiphyseal cartilage is present.

Rabbit 63, 5 days.

Aug. 18/14. Half-grown rabbit.

Right knee. Medial incision. Joint opened. Patella displaced laterally. Cartilage removed (with knife) from trochlear surface between ridges of condyles (1 x .5 cm.). Aponeurosis sutured with plain gut, the skin also. Collodion.

Aug. 23. Died.

AUTOPSY, Aug. 24. Knee looks normal. Wound is clean. The skin over the anterior and medial aspect of the joint shows extravasation

Low-power photomicrograph, showing the appearance of the wounded region shortly after injury.

of blood. About line of incision into joint, the vessels are injected. Joint appears normal—removed. Evidences of peritonitis. An exudate is present over the liver, and in the pelvis.

Aug. 24. Joint opened by lateral incision. It contains no exudate. The synovial membrane is slightly injected and succulent. Joint put into formalin, 3%.

Aug. 26. Transverse section made with saw through denuded area on trochlear surface of femur. Specimen placed in 5% HNO_3.

HISTOLOGY.—The cartilage has been thoroughly scraped from the bone between condylar eminences, the debris lying partly at site of the wound. The cartilage has been partly scraped off also from the eminences, and the synovial membrane is creeping over the cartilage at the side of the eminences, forming a perichondrium. The marrow is very much engorged.

Rabbit 64, 237 days.

Aug. 17/14. Half-grown white rabbit.

Right knee; medial incision. Joint opened. Patella displaced laterally. Cartilage removed (with knife) from trochlear surface between intercondylar ridges, area 5 x 8 mm. Aponeurosis sutured with plain gut, the skin also. Collodion.

Apr. 15/15. The rabbit died last night. The joint apparently is normal to external observation, and is freely movable. Joint opened from above. The synovial membrane is slightly injected. The wound in the cartilage is identified. It feels rough when the handle of the scalpel is passed across it. Otherwise the joint is normal. There are no "border exostoses."

A, Cross-section of femur at site of injury.

B, Ligamenta alaria.

Diagnosis. Cause of death, pneumonia—probably tuberculous.

HISTOLOGY.—A thin, irregular layer of cartilage is present between the condylar ridges. It is irregular both in structure and in outline. In places it contains approximately the normal number of cells, in places very few. There is no sign of any spreading across of synovial membrane, nor of its creeping up the side of the condyles. Nothing abnormal appears in the bone or marrow except that the trabeculae are somewhat thickened. The marrow is lymphoid.

B. The synovial membrane is thick and villous. The villi are composed mostly of fat and of fibrous tissue, and are without increase of lymphoid elements. One very small, short remnant of epiphyseal line is present on one side of the femur.

Rabbit 65, 139 days.

Aug. 18/14. Half-grown rabbit.

Right knee. Denudation, as in preceding cases.

Jan. 7/15. Full-grown, healthy rabbit, killed by blow on head. Joint apparently normal. Motion normal. No sign of former incision.

Joint opened from above. The denuded area can be recognized easily. It is rough, and apparently bony. At its upper portion is a

small, deeper excavation about 3 mm. in diameter, whose bottom is also apparently bony. Slightly distal to this there is a depression on the lateral condylar ridge. Low down, the medial condylar ridge is very sharp. This sharpness is apparently caused by an excavation of its medial aspect. The synovial membrane looks normal. No sign of any "border exostoses."

A, Cross-section including deeper depression, and depression of lateral condylar ridge.

B, Cross-section lower down, including sharp medial condylar ridge.

HISTOLOGY.—*B*. The cartilage has been torn off, evidently by the saw, so that no reliable conclusion can be reached.

A. The joint surface is very irregular, with a rather deep depression at the middle. The cartilage is absent, except over the condylar ridges and for a short distance from them. It is thin, irregular in its structure, and provided with a perichondrium over the eminences, and shades off toward the middle into a thin layer of fibrous tissue. The fibrous tissue is backed up by a thin layer of bone, but the normal bone buttress is absent. Numerous capillaries are seen directly under the surface. One condylar eminence is thickened by the production of cartilage on its lateral aspect, in the shape of an ecchondrosis or teat, covered by a tissue transitional between cartilage and fibrous tissue. This has apparently been built up by a creeping of the synovial membrane over the side of the eminence.

The bone trabeculae are thin and sparse. The marrow near the joint is fatty; that on the shaft side of the thin strip of bone which evidently was the epiphyseal line, is lymphoid. The epiphyseal cartilage is not present.

While the small teat of cartilage might be termed a "border exostosis," the changes in the bone and cartilage are distinctly not those of the human arthritis deformans.

Rabbit 66, 253 days.

Aug. 18/14. Half-grown rabbit. Right knee. Denudation as in previous cases.

Apr. 28/15. Healthy adult rabbit. Joint freely movable. Killed by blow on back of neck. Operation wound cannot be distinguished. Joint opened from above. Denuded area recognized as a rough, depressed area between the condylar ridges. Its floor is apparently bone. A small, rounded tubercle, apparently covered by cartilage, is present on the medial ridge, at about the level of the middle of the denuded

area. Synovia and patella normal. A cartilaginous plaque is present in the synovial membrane over the site of the newly developed tubercle, —that is, facing it. No other "border exostoses."

A, Section of femur through wound and tubercle.

B, Plaque.

HISTOLOGY.—*A.* The cartilage is absent over the denuded area, except for a thin, irregular stretch near its middle. The cartilage over the undenuded ridges does not cease suddenly, abruptly, but thins slowly toward the mid-line. Over one eminence it is fibro-cartilaginous. The "tubercle" over the medial ridge, noted above, consists of an irregular mass of fibro-cartilage, attached by a pedicle to the summit of the condylar eminence. The lateral condylar ridge is squared off and flattened. It has the angular contour occasionally noticed in these specimens, rather than the normal rounded outline. Its lateral border, well away from the joint line, is excavated for a considerable distance, and in this excavation is a good-sized blood-vessel. The marrow is perhaps more fatty than usual.

B. Dense fibrous tissue—no sign of cartilage. Here and there can be seen small pieces of bone lying in collections, enmeshed in fibrin. The synovial membrane looks normal. In other words, small loose fragments of bone exist in the joint without causing inflammation.

The ecchondrosis on the condyle in this case apparently was caused by the creeping in of the synovial membrane.

Rabbit 67, 204 days.

Aug. 18/14. Half-grown rabbit.

Right knee. Denudation as in previous cases.

Mar. 10/15. Rabbit killed by blow on the head. Wound healed. Hair has grown over it. Joint freely movable. Joint opened from above. Denuded area is hard to identify with the eye, but to the handle of the scalpel it feels decidedly rough. The surface is at the same level as the surrounding cartilage. No evidence of "border exostoses" is present. Small excavation of medial ridge just above condyle can be seen. The joint structure is otherwise normal.

HISTOLOGY.—The cartilage over the two eminences is present, though one side is thinner than the other, and the arrangement of the cells in both is very irregular. The denuded area has at its surface a tissue transitional between bone and cartilage. There is no evidence of the formation between the condylar eminences of new cartilage. The tissue looks like the bone which ordinarily underlies the joint cartilage.

Apparently there has been practically no change since the operation, except a shading off of the border of the denudation, and possibly the re-formation of cartilage over the condylar eminences. A thick layer of cartilage is continued over the lateral aspect of one condyle much thicker and to a greater distance than normal. The marrow is lymphoid. No epiphyseal line.

Rabbit 68, 12 days.

Aug. 18/14. Half-grown rabbit. Right knee. Denudation as in previous cases.

Right knee. Medial incision. Joint opened. Patella displaced laterally. Cartilage removed (with knife) from the trochlear surface of the femur between the ridges. Area of denudation 6 x 10 mm.

Aponeurosis sutured with plain gut, the skin also. Collodion.

Aug. 30. Rabbit died.

AUTOPSY.—Wound healed. Everything clean. Joint removed. Opened by longitudinal medial incision. Synovial membrane is injected and succulent. Denuded area identified. Transverse section, taking in the denuded area, put into Orth's fluid.

HISTOLOGY.—The bone between the eminences is laid bare, and the marrow in the immediate vicinity, under the wound, is composed largely of fibrous tissue, with here and there islands of cartilage cells, and occasionally small islands in the marrow, directly beneath the joint. Deeper in, the marrow is haemorrhagic. At one side of the wound on the surface is a small mass composed of detritus, and small pieces of bone and cartilage, some of them dead. There is another similar collection on the side of the condyle,—that is, in the recess of the joint, and attached to the fibrous tissue under it. The synovial membrane is creeping up over the side of the condyles, having the appearance of a regular perichondrium. The cartilage is present over the very tip of the eminences, but does not run far out on the joint. The epiphyseal line is present.

CONCLUSION

1. In a small proportion of cases new cartilage forms across the injured area.

2. In a certain proportion, cartilage forms over part of the area.

The source of production of the new cartilage in classes 1 and 2 cannot be determined with certainty, but the evidence points to the conclusion that the cartilage production is by the spreading inward of the synovial membrane in the form of a perichondrium.

3. In a large proportion the space between the condylar eminences remains bare.

4. In most cases new cartilage forms over the condylar eminences. Apparently this new cartilage is formed by the "perichondrium,"—that is, by the spreading in of the synovial membrane. This new cartilage is more irregular in its structure than is normal cartilage and is peculiar in the collection of the cells into large groups.

5. In a few of the joints changes were noted corresponding to those of the German "arthritis deformans" (Axhausen's Randexostosen); but in the great majority these changes did not take place.

6. In a few, changes were noted of a type entirely different to those of the German arthritis deformans, namely, Ely's Type I, Nichols and Richardson's proliferative form, Goldthwait's atrophic arthritis, etc.

7. In the great majority, the joint changes were localized to the area of injury. In other words, no general joint changes were set in motion.

8. Function was not disturbed by cartilage injury.

9. The marrow in some cases was fibrous, in others fatty.

10. Loose fragments of bone in the joint tend to become enmeshed in fibrin and to produce no other joint changes.

11. If a wound is made in the capsule immediately adjacent to its line of junction with the bone, bone and cartilage may be deposited in the resulting scar, by extension from the adjacent bone and cartilage.

In one or two cases the hypertrophic bone changes observed in the patella possibly were caused by the clumsy sewing up of the wound in the immediate vicinity, thereby damaging the synovial membrane. This circumstance indicates that perhaps the extensive changes noted by Axhausen in his experiments were due to faulty technique, and to the widespread damage done by his electro-cautery.

One of the most important of the conclusions drawn from this and from the two preceding series is that cartilage can be formed by synovial membrane, especially when exposed to pressure. When not exposed to pressure the synovial membrane does not undergo this change.

The engorgement of the marrow in those animals dying of intercurrent disease is quite marked.

III

REMOVAL OF CARTILAGE, AND BORING THROUGH THE SUBJACENT BUTTRESS

In this series of experiments the cartilage was removed from a wide area of the intercondylar groove on the anterior aspect of the lower end of the right femur of the rabbit and partly also from the condylar eminences. This area was approximately 5 x 10 mm., with the long diameter longitudinal, about the same size as in the preceding series. In addition a hole about 1.5 mm. in diameter was bored at about the center of the denuded area through the subjacent bone buttress into the marrow. The operations were done under general anaesthesia, with the technique described in the last series. The fixing, decalcification, imbedding, and staining were as in the previous series.

Rabbit 69, 138 days.

Half-grown rabbit.

Aug. 19/14. Medial incision alongside of patella and tendon. Joint opened. Synovial membrane is thickened and injected. Patella displaced laterally, and cartilage removed with a knife from trochlear surface of femur. Hole about 1.5 mm. in diameter made into marrow in center of denuded area of femur with awl. Patella replaced. Aponeurosis and skin sutured with plain gut. Collodion.

Jan. 7/15. Full-grown, healthy rabbit, killed by blow on back of neck. The joint appears normal. Motion normal. Joint opened from above. The synovia appears decidedly thickened and injected. The denuded area is easily recognized. It is rough, and its base seems to consist of bone covered by fibrous tissue. The bored area is still deeper, and its floor is similar. Alongside it there is a deep indentation of the lateral condylar ridge as if it had been eaten away.

The condyles of the femur (that is, the condyles proper) are somewhat roughened. There seems to be a little lipping of the medial tuberosity of the tibia, as compared with that of the opposite side.

A, Cross-section of condylar ridges, with deep hole and irregularity of condylar ridge.

B, Cross-section of condyles proper,—that is, facing the tibia.

C, Cross-section of tibia.

HISTOLOGY.—*A*. No normal cartilage is present on the entire joint surface. The surface is very irregular. Over one condylar eminence (the medial?) the cartilage is irregular in structure and outline. The cells show a marked tendency to grouping, and at one spot at about the apex of the eminence, is a small hook-like process consisting of chondro-mucin with a few cells. On the medial aspect of this medial condyle the cartilage is continued for some distance, and is covered by fibrous tissue and synovial membrane. In other words, the synovial membrane is creeping up over the condyle in the form of a perichondrium. The other condylar eminence is gone, and the marrow is exposed to the joint. This marrow is partly fibrous. The lateral aspect consists of bare spongy bone and marrow, and is not covered by capsule or periosteum.

A new-formed, irregular layer of cartilage covers the bone between the condylar eminences. Its surface is more or less wavy, and most of its cells have no capsules, and are irregular in shape and size. The transition between the cartilage and the subjacent bone is a gradual one. The marrow is mostly fatty. The location of the bored hole cannot be distinguished. The bony buttress near the joint is increased in thickness. The epiphyseal line is present.

B. The surface of the cartilage of the condyles presents several small elevations. The cells are flattened out and are without capsules. In places, small filaments of cartilage are partly torn loose and resemble fibrous tissue.

C. The cartilage over one tuberosity is thin, and its cells are gathered in irregular groups. The cartilage over the other is thicker (probably about normal) and its cells are arranged more regularly, in columns. At the margin of this latter tuberosity (presumably the medial) the bone is thickened. The cartilage is also thickened, and is covered by a mass of fibrous tissue, all three—bone, cartilage and fibrous tissue—making a little knob.

This is evidently a case of new formation of cartilage, and of extensive general joint changes following the injury.

Rabbit 70, 240 days.

Half-grown rabbit.

Aug. 19/14. Operation the same as on rabbit 69. Denuded area about 6 x 10 mm. Hole about 2 mm. in diameter.

Apr. 26/15. Healthy rabbit. Killed by blow on head. Joint normal in external appearance. Movement free. Joint opened from above. Wounded area identified. It is decidedly rough in places, fairly smooth

in other places, and depressed. The lateral ridge at the level of the wound has suffered a slight loss of substance, forming a slight concavity. Cross-section of femur including irregularity of condylar ridge into 80% alcohol. Synovial membrane normal.

Histology.—The eroded lateral condylar ridge is much lower than normal, and consists of bone, bare in places, and in other places covered with a thin layer of fibrous tissue. Where the hole was bored through the bone, a fairly thick layer of cartilage is present, whose cells are somewhat irregular in their grouping and arrangement, but which otherwise is fairly normal. The bone under this whole (punctured) area is thicker than normal, and the marrow is lymphoid. The rest of the denuded joint surface is covered by thin cartilage, the outline of which is irregular. This is underlaid by a very thin buttress of bone, and the bone trabeculae beneath it are thin and sparse. The marrow is fatty. The summit of the medial condylar ridge is covered with cartilage, the cells of which are arranged in somewhat large groups, and stain very deeply with haematoxylin. There are large areas of basement substance without cells in this cartilage. The synovia is decidedly thickened, and this thickening consists of fibrous tissue. The cellular layer at the surface is not thickened.

This experiment shows a development of new cartilage.

Rabbit 71, 92 days.

Half-grown rabbit.

Aug. 19/14. Same operation as in 69. Denuded area about 6 x 10 mm. Hole 2 mm. in diameter.

Nov. 19. Animal killed by blow on back of neck. Function of the operated joint is perfect. The operation wound is healed completely. Joint opened from above. Denuded area identified. It is rough to the feel of a blunt instrument passed over it. The position of the hole punched through the bone is identified. It is filled up with a white glistening substance which is smoother than the denuded area and looks like cartilage. There is an excavated area on the medial aspect of the medial condyle, and this excavation extends over to the intercondylar groove. The synovia appears thickened. There are no "border exostoses."

A, Section including the site of original hole into marrow.

B, Excavation on medial condyle.

C, Capsule.

A, *B* and *C* into 80% alcohol.

Low-power photomicrograph showing new cartilage formed over part of the denuded area. This picture is taken from another section than the one described.

High-power photomicrograph of the new cartilage.

Histology.—*B*. The "*excoriation*" was evidently caused by the splitting off at operation of the side of the condyle, which was torn partly off, turned over, and lies proximal to its normal position. Its former bed has been filled in with fibrous tissue.

A. The denuded area cannot be identified exactly. Part of its surface is bony and part cartilage. Starting from one condyle, one sees a strip of cartilage of approximately normal thickness, of decidedly ir-

regular structure. The cells show arrangement in groups. This layer tapers off, until at about one-fourth of the distance across the joint the bony buttress is exposed for a very short distance. Then comes a small island of cartilage, whose cells are arranged in groups of varying sizes. Then comes a small notch exposing the bone, then a strip of tissue for about one-fifth of the joint, not quite as thick as normal cartilage. This is a transitional tissue, resembling bone and cartilage. It passes into a small thin strip of cartilage of irregular structure, which appears to be undergoing ossification. Then comes a small depressed area of denuded bone. Then a strip of cartilage running up to the condylar eminence, whose structure is similar to that covering the other condyle, but which is shorter than it. There is no sign of the hole punched through the bone. In the place where the puncture should be, the bone trabeculae are thickened and numerous, and in the marrow below this again are irregular islands of cartilage, apparently transforming into bone. In one section the cartilage cells can be traced almost up to the joint from these islands.

Other slides show a somewhat different picture. The condylar eminences show a rift more or less complete, running almost parallel to the surface; and the connection of the layer next the surface with the synovial membrane creeping up the side of the condyle, is evident. The arrangement of the cartilage cells in the condyles is in irregular groups, separated by areas of basement substance. The arrangement in the overlying layer just mentioned is different from that of the layer beneath it. In the overlying layer the cells are more closely packed, and are arranged generally parallel to the surface. They look like the cells in the fibrous tissue at the side of the condyle. The epiphyseal line is present, though thin and irregular.

C. The synovial membrane is thickened by the production of fibrous tissue, and is villous. The villi are composed largely of fibrous tissue. Not much cellular infiltration is present.

This is an example of new cartilage formation. The new cartilage over the condyles has evidently been formed by the synovia creeping up over the site of the condyle, in the form of a perichondrium. Presumably the new-formed cartilage adjoining one of the eminences has been formed in the same manner.

Rabbit 72, 250 days.

Half-grown rabbit.

Aug. 19/14. Right knee. Medial incision alongside of patella and tendon. Joint opened. Patella displaced laterally. Cartilage removed

with knife from trochlear surface of femur between the ridges, area about 6 x 10 cm. Hole about 2 mm. in diameter made with awl into spongy bone below. Patella replaced. Aponeurosis sutured with plain gut, the skin also. Collodion.

AUTOPSY, Apr. 26/15. Healthy rabbit, killed by blow on back of head. Joint apparently normal, movements free. Joint opened from above. The gouged area is somewhat depressed, and is rough to the handle of the scalpel. Beginning at about the middle of the injured area and extending distally for a short distance, the medial condylar ridge is eaten away. Cross-section of femur, including gouged area and area eaten away. Synovia normal.

HISTOLOGY, Sept. 1. The cartilage on the lateral condylar ridge is normal as to thickness, but is irregular in its structure and cell distribution. The creeping over it of the synovial membrane can be distinguished plainly. The cells in places are abundant, and in places absent. The cartilage then becomes gradually thinner. Its free surface is fairly smooth. Passing along, we come to the place where the puncture was made. Here the cartilage is somewhat thicker. The thickening is partly at the expense of the subjacent bone. Adjacent to this is a short stretch of bare bone, and then a thin, irregular stretch of cartilage over the medial condylar ridge. The synovial membrane is thickened.

The medial condylar ridge is flattened, and angular instead of curved. The marrow is somewhat fatty in areas, but is mostly lymphoid. The bone trabeculae beneath the puncture are somewhat thickened.

The formation of new cartilage on one eminence by the synovial membrane spreading in, is evident.

Rabbit 73, 252 days.

Half-grown rabbit.

Aug. 19/14. Right knee. Operation same as in the four preceding experiments. Area denuded about 6 x 10 mm. Hole in femur about 2 mm.

Apr. 28/15. Adult healthy rabbit, killed by blow on back of neck. Joint freely movable, and scar not recognized. Joint opened from above. Wounded area identified as a slightly depressed, partly smooth, and partly rough area. Cartilage appears to have formed at its lower portion. No border exostoses are seen.

A, Upper or bare portion.

B, Lower, or portion with apparent cartilage formation. Patella and synovia normal.

Histology.—*B*. Cartilage stretches across from condyle to condyle, except over one very small area, where there is bare bone. This is at one side of the presumable drill-hole. The other side is shown in some slides by a notch or depression running down through the cartilage to the bone. In other slides this notch is not present. The cartilage over the drill-hole is of about normal thickness, but appears more fibrous than normal. The bone trabeculae and buttress under it are decidedly thickened. None of the cartilage is normal. It all shows the irregularity of structure so often noted. Apparently it is all new-formed. The synovia can be seen spreading in up to the apex of one condyle. Near the apex of this condyle the articular cartilage sends an offshoot for a short distance into the marrow below it, where it terminates in a strand of fibrous tissue. The deep portion of this cartilage is transforming into bone. The marrow near the joint is fatty. Deeper in, it is lymphoid.

We interpret this as a walling off of the joint from the marrow by new bone, and a production of new articular cartilage throughout, part at least by the synovia.

A. The buttress of bone is much thinner than in *B*. Some of the slides show a thin, irregular strip of cartilage over it, with bare bone at one area; others a thin layer of fibrous tissue looking like synovial membrane, or of bare bone, with very little cartilage,—that is, over the puncture. The cartilage over the condyles is present, but of irregular structure. Over one eminence it is of normal thickness, over the other thinner.

Rabbit 74, 203 days.

Half-grown rabbit.

Aug. 19/14. Right knee. Operation same as in preceding cases. Area of denudation and hole, the same.

Mar. 10/15. Full-grown, healthy rabbit, killed by blow on head. Scar not seen. Joint apparently normal. Movements normal. Joint opened from above. The exact limits of the original area of denudation cannot be defined. An irregular depressed area somewhat larger than the bored hole is present at the site of injury. The bottom of this area apparently consists of bone. A shallow groove from which cartilage is absent extends outward over the lateral ridge. The posterior surface of the patella, which lies directly over the defined area, is slightly roughened. Otherwise the joint appears normal—no "border exostoses." Specimen *A*, transverse section removed from wounded area. Placed in 80% alcohol.

HISTOLOGY.—One condylar eminence is covered by cartilage, which shows the usual arrangement of its cells in large groups separated by basement structure, the other is covered by fibro-cartilage. No distinction between the denuded and the punctured areas can be made. Between the two eminences is an excavation, which begins quite sharply on each side. It presents no cartilage, but a thin layer of fibrous tissue, whose surface looks like that of synovial membrane. Underneath the fibrous tissue is bone, and through small apertures in this bony wall the fibrous tissue communicates with the marrow. At the side of one eminence the creeping up of the synovia can be distinctly seen. The marrow itself appears normal lymphoid. The synovia is normal.

Apparently the formation of new cartilage over both eminences has been by synovial membrane. In other words, the synovial membrane over both eminences, where it has been exposed to pressure, has transformed into cartilage. In the excavation between the eminences, where the synovial membrane has not been exposed to pressure, it has retained its structure.

CONCLUSIONS

If the cartilage be removed from the intercondylar groove on the front of the rabbit's femur, and more or less from the condylar eminences, and if in addition a hole be bored through the bone buttress into the marrow, new cartilage will be formed over the entire joint surface or over the greater portion of it. This new cartilage is formed, at least to a large extent, by the synovial membrane, spreading in from the circumference. In those cases where, on account of irregularity of the surface, the synovia is not exposed to pressure, it may retain its structure and may not transform into cartilage.

Whether or not the tissue from the marrow takes part in the formation of new cartilage, it is impossible to say. As these cases show a production of cartilage more nearly complete than the cases of the previous series, this question may be answered tentatively in the affirmative. In fact, the whole process of plugging up the hole with bone and cartilage, in this series, seems to have been through the activity of the marrow.

The new cartilage is always irregular in structure, and usually in outline. It may be partly fibro-cartilage. The hole bored through into the marrow always becomes closed off by bone, and the bone trabeculae are thickened. The new-formed cartilage, it may be noted, has much the same appearance as has the cartilage in "arthritis deformans."

As a rule the joint changes are confined to the area of injury. The marrow is usually fatty in whole or in part. In one or two instances the injury was followed by a marked destructive process in the bone at the site of the injury. Function remains perfect in these joints.

Ossification through the medium of islands of cartilage in the marrow of the epiphysis was noted once. This intracartilaginous ossification is seen in "arthritis deformans"—that is, in arthritis of Type II.

An injury of the joint cartilage, then, accompanied by an injury of the subjacent bone and marrow, sufficient to cause their actual destruction, is often followed by a repair of these tissues more or less complete,—an actual regeneration of them. The new cartilage looks like that found in what the Germans call "arthritis deformans." In other words what Axhausen regarded as a disease produced by his electric needle was actually the result of the process of repair.

REGENERATION OF BONE MARROW

By Leonard W. Ely

The following series of experiments was done to ascertain if the marrow regenerated completely after it had been removed from the shaft of a long bone. Rabbits were employed. Under ether anaesthesia, and after shaving and disinfection of the skin, a trephine opening was made in the cortex of the right tibia, either through the antero-medial aspect or through the crest. A small scoop was inserted into the opening, and as much of the marrow as could be reached was removed. In the earlier cases a long piece of the cortex was removed, but this weakened the bone. The wound was sutured, and dressed with collodion. At varying intervals thereafter the animals were sacrificed. By a combination of sawing and splitting, the marrow cylinder was removed, fixed in Zenker's fluid, dehydrated in alcohol, mounted in paraffin, and stained with haematoxylin and eosin, and with methyl blue and eosin.

Rabbit 114.

Sept. 30/15. Ether, customary shaving and skin disinfection.

Incision over the front of right tibia (middle third), separating periosteum. With cutting forceps, the cortex of the anterior surface of the tibia was nicked at two points about 2 cm. apart, and then with the scalpel the anterior cortex of the bone was removed, exposing marrow. The marrow was removed with a scoop. The wound was sewed up with two layers of catgut. Collodion dressing and plaster of Paris applied.

Oct. 21. Killed on account of infection of compound fracture. Material thrown away.

Rabbit 115, 77 days.

Almost full-grown animal.

Sept. 30/15. Preparation as in rabbit 114; incision as before. Removal of about 2 cm. of anterior portion of cortex of right tibia. Removal of marrow 2 cm. in extent from interior of the shaft. The wound was sewed up with two layers of catgut and dressed with collodion.

Oct. 4. Leg broken. Plaster of Paris applied.

Oct. 21. Foot swollen. Plaster removed.

Dec. 16. Rabbit, in health, killed by blow on back of head. The tibia has healed with considerable callus and angular deformity. Sawn longitudinally. The marrow canal is patent throughout, but the cylinder of marrow is adherent in the region of the fracture. Below the fracture it is yellow, above lymphoid. Marrow into Zenker's fluid.

HISTOLOGY.—The marrow of the upper portion is a mixture of lymphoid and fatty, with lymphoid at the periphery and the fatty generally at the center in a band which varies in width, growing wider from above downward. Then comes an area exclusively lymphoid at about the middle of the cylinder. The lower portion is practically all fatty, with a little lymphoid at the periphery. At the lower end the lymphoid at the periphery ceases entirely.

Rabbit 116.

Oct. 13/15. Adult rabbit. Usual skin disinfection. A trephine opening was made with cutting bone forceps through crest of the right tibia. By accident the whole anterior cortex of lower part of the bone was broken. With a scoop practically all the marrow was removed. Wound sewed with catgut, two layers. Collodion and plaster of Paris dressing.

Oct. 26. Rabbit died.

AUTOPSY, Oct. 27. One fragment of bone nearly through skin. On section, bone end found surrounded by cheesy pus. Specimen thrown away.

Rabbit 117, 61 days.

Oct. 13/15. Full-grown rabbit. Duplicate of preceding operations. Incision over the subcutaneous portion of right tibia about its middle. With a drill the cortex on the subcutaneous surface of tibia was bored through, and the hole was enlarged with bites of the cutting forceps. The marrow was removed by a scoop practically from the entire canal of the tibia. The wound was sewed up with catgut in two layers. Collodion.

Dec. 13. Rabbit killed by blow on back of head. He is full-grown. The wound has healed and the hair has grown over it. No sign of infection. Tibia removed. It is rough at the seat of operation, and has one or two holes in its cortex into which a pin-point can enter. Tibia sawn longitudinally. There is not the same division into red and yellow marrow of the upper and lower ends, as noted in 122, etc., either in right or left tibia.

HISTOLOGY.—The marrow from the operated tibia contains areas of lymphoid and of fatty marrow. It differs from the marrow of the other

tibia chiefly in its lesser content of lymphoid elements. The marrow of the unoperated side is practically exclusively lymphoid.

Rabbit 119, 49 days.

Oct. 21/15. Young animal. Operation as on animal 117.

Dec. 9. Full-grown rabbit, in health, killed by blow on back of head. Tibia removed. The bone is thickened and rough at site of operation. Tibia sawn longitudinally. The marrow in the upper portion is deeper in color than in the lower, but the difference is not as marked as in one or two of the other animals. The marrow of the other tibia was also removed for comparison. Its upper portion is of deeper red than that of the operated tibia.

Histology.—The upper portion of the cylinder of the operated side (about three-fifths) is dense lymphoid, with one small area of fatty in the neighborhood of a fair-sized arteriole. The lower portion is fatty, with a little lymphoid at the periphery.

Normal tibia. The upper part of the cylinder consists of a mixture of lymphoid and fatty marrow. In a general way one side of the film (about one-half) is lymphoid, the other side fatty. This specimen does not show the tendency of the lymphoid elements to collect at the periphery, leaving the center fatty. The lower portion (about two-fifths) of the specimen consists mostly of fatty marrow, but with some lymphoid elements, especially at the periphery.

The marrow of the operated tibia differs from the other in containing more lymphoid elements.

Rabbit 120, 49 days.

Oct. 21/15. Rather young animal. Operation as on rabbits 117 and 119.

Dec. 9. Animal killed by blow on back of neck. The rabbit is full-grown. The wound is healed completely, and the hair has grown over it. Tibia removed. The hole is closed by bone, which is thickened at site of the operation. Bone sawn lengthwise. The marrow is red above, but mottled. Below it is paler. Marrow into Zenker's fluid.

Histology.—In this specimen the upper or lymphoid part can be distinguished from the lower or fatty, though the line of division is not sharp. The lymphoid elements of the former show a marked tendency to grouping at the periphery.

Rabbit 121, 36 days.

Oct. 28/15. Rather young animal. Repetition of previous operation of removal of marrow from right tibia.

Dec. 3. Animal killed by blow on the back of the neck. The rabbit is larger than when operated. The wound is healed completely. Tibia removed. It is thickened over site of operation and the opening will just admit the shaft of a pin. Bone sawn lengthwise and marrow removed. The upper two-thirds is lymphoid, including that portion in the neighborhood of the trephine opening. The lower third is fatty. This marrow, red above and yellow below, is not abnormal. The normal tibia has the same condition.

HISTOLOGY.—A similar difference as to the quality of the upper and lower portions of the cylinder is present as in rabbit 122, but the change is not so sharp nor so pronounced. Lymphoid islands are seen in the lower, fatty portion. The grouping of the lymphoid elements at the periphery of the upper part is not marked. Myeloplaxes are fairly abundant.

Rabbit 122, 36 days.

Oct. 28/15. Full-grown rabbit. Repetition of former operations of removing marrow from inside of right tibia, through trephine opening.

Dec. 3. Rabbit is pregnant. Killed by blow on back of neck. The rabbit evidently was only partly grown, for it is much larger than at time of operation. About the site of the trephine opening the bone is roughened and thickened, and the hole is closed.

Bone sawn lengthwise. The marrow looks normal; lymphoid in the upper three-fifths of the shaft, and fatty below. Under the trephine opening and for some distance below it the marrow is lymphoid.

HISTOLOGY.—The larger, upper portion of the marrow cylinder shows a mixture of lymphoid and fatty marrow, with a general tendency of the lymphoid elements to gather at the periphery, while the marrow at the center is more fatty. The change from this marrow of the upper three-fifths to that of the lower two-fifths is rather sudden. In the lower portion the marrow is fatty. Blood sinuses abound in the upper portion, growing scarce, and finally cease in the lower portion. Myeloplaxes with their "basket" nuclei are seen with fair frequency in the upper portion.

CONCLUSION

If the marrow be removed from the shaft of the rabbit's tibia, it will quickly regenerate, without any trace of the operation. Possibly the lymphoid element is less than normal in the operated marrow.

The peculiar division of the marrow into lymphoid above and fatty below is noteworthy.

A STUDY OF ONE HUNDRED DRY BONES SAWN IN THE LABORATORY

By Leonard W. Ely

The following study was undertaken to determine whether a routine examination of many bones would reveal a departure from the normal in the structure of a considerable number, and if so, what the changes would be.

The material was furnished, by courtesy of Professor Meyer, from the anatomical department of Stanford University. Old, dry bones were sawn into slices about 5 mm. in thickness, with a band-saw. The ends of the bones received particular attention. The results, of course, were not as satisfactory as if fresh material had been at hand, but, as will be seen, a number of interesting facts were brought out.

To Professor Meyer my thanks are due for his aid in my investigation.

Bone 1. Tibia. Negative.

Bone 2. Femur. Old cavity in the head of the bone, about 5 mm. from the lower portion of the joint line. The cavity itself is about 5 mm. in diameter, has irregular walls, and is filled with a plug of marrow.

Bone 3. Tibia. Negative.

Bone 4. Tibia. Negative.

Bone 5. Femur. Lower extremity presents well marked lesions of Type II arthritis. At about the location of the crucial ligaments in the intercondylar notch, the bone is decidedly thickened, and directly beneath the thickened bone is a cavity about 8 x 12 mm. in diameter, whose walls are rough, but not thickened. The walls, while rough, are nevertheless too smooth to permit the assumption that the cavity was formed post-mortem.

Bone 6. Tibia. The articular surface of the inner tuberosity is somewhat rough, and presents a small bony nodule near its center. Nothing of note appears on sawing.

Bone 7. Right Tibia. Negative.

Bone 8. Left Tibia. Negative.

Bone 9. Left Tibia. Nothing worthy of note.

Bone 10. Left Femur. The bone seems denser than normal, both above and below.

Bone 11. Left Femur. Nothing worthy of note.

Bone 12. Lower end of Left Femur. Nothing worthy of note.

Bone 13. Left Tibia. Nothing worthy of note.

Bone 14. Upper end of Left Tibia. Tuberosities present slight changes of Type II arthritis; slight lipping. The bone in the tuberosities seems a trifle dense on sawing.

Bone 15. Lower end of Left Femur. Very slight lipping of the condyles. The bone in the condyles is rather dense.

Bone 16. Lower end of Right Femur. The condyles show slight changes of arthritis of Type II, namely, slight lipping, and small, wart-like exostoses on their articular surface.

Bone 17. Lower end of Right Femur. Well marked lipping of condyles. Nothing of note on sawing.

Bone 18. Lower end of Left Femur. Very slight lipping of the condyles.

Bone 19. Right Femur. Nothing of note.

Bone 20. Right Tibia. Nothing of note.

Bone 21. Right Femur, upper end. Well marked changes of Type II arthritis. Lipping and bony outgrowth on the articular surface.

Bone 22. Upper end of Left Femur. Very slight lipping of articular surface. Nothing of note on sawing.

Bone 23. Upper end of Left Femur. Nothing of note.

Bone 24. Upper end of Right Tibia. Nothing of note.

Bone 25. Upper end of Right Tibia. Slight lipping of tuberosities. Nothing of note on sawing.

Bone 26. Upper end of Right Humerus. Slight changes of Type II arthritis—irregularity of joint surfaces and lipping.

Bone 27. Upper end of Left Femur. Nothing of note.

Bone 28. Lower end of Left Humerus. Nothing of note.

Bone 29. Upper end of Left Ulna. Nothing of note.

Bone 30. Lower end of Right Femur. Moderate lipping of condyles. Nothing of note on sawing.

Bone 31. Upper end of Right Tibia. Nothing of note.

Bone 32. Lower end of Left Femur. Very slight lipping of condyles.

Bone 33. Right Scapula. Nothing of note.

Bone 34. Lower end of Right Humerus. Nothing of note.

Bone 35. Right Os Innominatum. Nothing of note.

Bone 36. Lower end of Right Femur. Nothing of note.

Bone 37. Half of a lumbar vertebra. Nothing of note.

Bone 38. Head of Femur. Nothing of note.

HISTOLOGY.—One condylar eminence is covered by cartilage, which shows the usual arrangement of its cells in large groups separated by basement structure, the other is covered by fibro-cartilage. No distinction between the denuded and the punctured areas can be made. Between the two eminences is an excavation, which begins quite sharply on each side. It presents no cartilage, but a thin layer of fibrous tissue, whose surface looks like that of synovial membrane. Underneath the fibrous tissue is bone, and through small apertures in this bony wall the fibrous tissue communicates with the marrow. At the side of one eminence the creeping up of the synovia can be distinctly seen. The marrow itself appears normal lymphoid. The synovia is normal.

Apparently the formation of new cartilage over both eminences has been by synovial membrane. In other words, the synovial membrane over both eminences, where it has been exposed to pressure, has transformed into cartilage. In the excavation between the eminences, where the synovial membrane has not been exposed to pressure, it has retained its structure.

CONCLUSIONS

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Whether or not the tissue from the marrow takes part in the formation of new cartilage, it is impossible to say. As these cases show a production of cartilage more nearly complete than the cases of the previous series, this question may be answered tentatively in the affirmative. In fact, the whole process of plugging up the hole with bone and cartilage, in this series, seems to have been through the activity of the marrow.

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As a rule the joint changes are confined to the area of injury. The marrow is usually fatty in whole or in part. In one or two instances the injury was followed by a marked destructive process in the bone at the site of the injury. Function remains perfect in these joints.

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Rabbit 114.

Sept. 30/15. Ether, customary shaving and skin disinfection.

Incision over the front of right tibia (middle third), separating periosteum. With cutting forceps, the cortex of the anterior surface of the tibia was nicked at two points about 2 cm. apart, and then with the scalpel the anterior cortex of the bone was removed, exposing marrow. The marrow was removed with a scoop. The wound was sewed up with two layers of catgut. Collodion dressing and plaster of Paris applied.

Oct. 21. Killed on account of infection of compound fracture. Material thrown away.

Rabbit 115, 77 days.

Almost full-grown animal.

Sept. 30/15. Preparation as in rabbit 114; incision as before. Removal of about 2 cm. of anterior portion of cortex of right tibia. Removal of marrow 2 cm. in extent from interior of the shaft. The wound was sewed up with two layers of catgut and dressed with collodion.

Oct. 4. Leg broken. Plaster of Paris applied.

Oct. 21. Foot swollen. Plaster removed.

Dec. 16. Rabbit, in health, killed by blow on back of head. The tibia has healed with considerable callus and angular deformity. Sawn longitudinally. The marrow canal is patent throughout, but the cylinder of marrow is adherent in the region of the fracture. Below the fracture it is yellow, above lymphoid. Marrow into Zenker's fluid.

HISTOLOGY.—The marrow of the upper portion is a mixture of lymphoid and fatty, with lymphoid at the periphery and the fatty generally at the center in a band which varies in width, growing wider from above downward. Then comes an area exclusively lymphoid at about the middle of the cylinder. The lower portion is practically all fatty, with a little lymphoid at the periphery. At the lower end the lymphoid at the periphery ceases entirely.

Rabbit 116.

Oct. 13/15. Adult rabbit. Usual skin disinfection. A trephine opening was made with cutting bone forceps through crest of the right tibia. By accident the whole anterior cortex of lower part of the bone was broken. With a scoop practically all the marrow was removed. Wound sewed with catgut, two layers. Collodion and plaster of Paris dressing.

Oct. 26. Rabbit died.

AUTOPSY, Oct. 27. One fragment of bone nearly through skin. On section, bone end found surrounded by cheesy pus. Specimen thrown away.

Rabbit 117, 61 days.

Oct. 13/15. Full-grown rabbit. Duplicate of preceding operations. Incision over the subcutaneous portion of right tibia about its middle. With a drill the cortex on the subcutaneous surface of tibia was bored through, and the hole was enlarged with bites of the cutting forceps. The marrow was removed by a scoop practically from the entire canal of the tibia. The wound was sewed up with catgut in two layers. Collodion.

Dec. 13. Rabbit killed by blow on back of head. He is full-grown. The wound has healed and the hair has grown over it. No sign of infection. Tibia removed. It is rough at the seat of operation, and has one or two holes in its cortex into which a pin-point can enter. Tibia sawn longitudinally. There is not the same division into red and yellow marrow of the upper and lower ends, as noted in 122, etc., either in right or left tibia.

HISTOLOGY.—The marrow from the operated tibia contains areas of lymphoid and of fatty marrow. It differs from the marrow of the other

tibia chiefly in its lesser content of lymphoid elements. The marrow of the unoperated side is practically exclusively lymphoid.

Rabbit 119, 49 days.

Oct. 21/15. Young animal. Operation as on animal 117.

Dec. 9. Full-grown rabbit, in health, killed by blow on back of head. Tibia removed. The bone is thickened and rough at site of operation. Tibia sawn longitudinally. The marrow in the upper portion is deeper in color than in the lower, but the difference is not as marked as in one or two of the other animals. The marrow of the other tibia was also removed for comparison. Its upper portion is of deeper red than that of the operated tibia.

Histology.—The upper portion of the cylinder of the operated side (about three-fifths) is dense lymphoid, with one small area of fatty in the neighborhood of a fair-sized arteriole. The lower portion is fatty, with a little lymphoid at the periphery.

Normal tibia. The upper part of the cylinder consists of a mixture of lymphoid and fatty marrow. In a general way one side of the film (about one-half) is lymphoid, the other side fatty. This specimen does not show the tendency of the lymphoid elements to collect at the periphery, leaving the center fatty. The lower portion (about two-fifths) of the specimen consists mostly of fatty marrow, but with some lymphoid elements, especially at the periphery.

The marrow of the operated tibia differs from the other in containing more lymphoid elements.

Rabbit 120, 49 days.

Oct. 21/15. Rather young animal. Operation as on rabbits 117 and 119.

Dec. 9. Animal killed by blow on back of neck. The rabbit is full-grown. The wound is healed completely, and the hair has grown over it. Tibia removed. The hole is closed by bone, which is thickened at site of the operation. Bone sawn lengthwise. The marrow is red above, but mottled. Below it is paler. Marrow into Zenker's fluid.

Histology.—In this specimen the upper or lymphoid part can be distinguished from the lower or fatty, though the line of division is not sharp. The lymphoid elements of the former show a marked tendency to grouping at the periphery.

Rabbit 121, 36 days.

Oct. 28/15. Rather young animal. Repetition of previous operation of removal of marrow from right tibia.

Dec. 3. Animal killed by blow on the back of the neck. The rabbit is larger than when operated. The wound is healed completely. Tibia removed. It is thickened over site of operation and the opening will just admit the shaft of a pin. Bone sawn lengthwise and marrow removed. The upper two-thirds is lymphoid, including that portion in the neighborhood of the trephine opening. The lower third is fatty. This marrow, red above and yellow below, is not abnormal. The normal tibia has the same condition.

Histology.—A similar difference as to the quality of the upper and lower portions of the cylinder is present as in rabbit 122, but the change is not so sharp nor so pronounced. Lymphoid islands are seen in the lower, fatty portion. The grouping of the lymphoid elements at the periphery of the upper part is not marked. Myeloplaxes are fairly abundant.

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Oct. 28/15. Full-grown rabbit. Repetition of former operations of removing marrow from inside of right tibia, through trephine opening.

Dec. 3. Rabbit is pregnant. Killed by blow on back of neck. The rabbit evidently was only partly grown, for it is much larger than at time of operation. About the site of the trephine opening the bone is roughened and thickened, and the hole is closed.

Bone sawn lengthwise. The marrow looks normal; lymphoid in the upper three-fifths of the shaft, and fatty below. Under the trephine opening and for some distance below it the marrow is lymphoid.

Histology.—The larger, upper portion of the marrow cylinder shows a mixture of lymphoid and fatty marrow, with a general tendency of the lymphoid elements to gather at the periphery, while the marrow at the center is more fatty. The change from this marrow of the upper three-fifths to that of the lower two-fifths is rather sudden. In the lower portion the marrow is fatty. Blood sinuses abound in the upper portion, growing scarce, and finally cease in the lower portion. Myeloplaxes with their "basket" nuclei are seen with fair frequency in the upper portion.

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To Professor Meyer my thanks are due for his aid in my investigation.

Bone 1. Tibia. Negative.

Bone 2. Femur. Old cavity in the head of the bone, about 5 mm. from the lower portion of the joint line. The cavity itself is about 5 mm. in diameter, has irregular walls, and is filled with a plug of marrow.

Bone 3. Tibia. Negative.

Bone 4. Tibia. Negative.

Bone 5. Femur. Lower extremity presents well marked lesions of Type II arthritis. At about the location of the crucial ligaments in the intercondylar notch, the bone is decidedly thickened, and directly beneath the thickened bone is a cavity about 8 x 12 mm. in diameter, whose walls are rough, but not thickened. The walls, while rough, are nevertheless too smooth to permit the assumption that the cavity was formed post-mortem.

Bone 6. Tibia. The articular surface of the inner tuberosity is somewhat rough, and presents a small bony nodule near its center. Nothing of note appears on sawing.

Bone 7. Right Tibia. Negative.

Bone 8. Left Tibia. Negative.

Bone 9. Left Tibia. Nothing worthy of note.

Bone 10. Left Femur. The bone seems denser than normal, both above and below.

Bone 11. Left Femur. Nothing worthy of note.

Bone 12. Lower end of Left Femur. Nothing worthy of note.

Bone 13. Left Tibia. Nothing worthy of note.

Bone 14. Upper end of Left Tibia. Tuberosities present slight changes of Type II arthritis: slight lipping. The bone in the tuberosities seems a trifle dense on sawing.

Bone 15. Lower end of Left Femur. Very slight lipping of the condyles. The bone in the condyles is rather dense.

Bone 16. Lower end of Right Femur. The condyles show slight changes of arthritis of Type II, namely, slight lipping, and small, wart-like exostoses on their articular surface.

Bone 17. Lower end of Right Femur. Well marked lipping of condyles. Nothing of note on sawing.

Bone 18. Lower end of Left Femur. Very slight lipping of the condyles.

Bone 19. Right Femur. Nothing of note.

Bone 20. Right Tibia. Nothing of note.

Bone 21. Right Femur, upper end. Well marked changes of Type II arthritis. Lipping and bony outgrowth on the articular surface.

Bone 22. Upper end of Left Femur. Very slight lipping of articular surface. Nothing of note on sawing.

Bone 23. Upper end of Left Femur. Nothing of note.

Bone 24. Upper end of Right Tibia. Nothing of note.

Bone 25. Upper end of Right Tibia. Slight lipping of tuberosities. Nothing of note on sawing.

Bone 26. Upper end of Right Humerus. Slight changes of Type II arthritis—irregularity of joint surfaces and lipping.

Bone 27. Upper end of Left Femur. Nothing of note.

Bone 28. Lower end of Left Humerus. Nothing of note.

Bone 29. Upper end of Left Ulna. Nothing of note.

Bone 30. Lower end of Right Femur. Moderate lipping of condyles. Nothing of note on sawing.

Bone 31. Upper end of Right Tibia. Nothing of note.

Bone 32. Lower end of Left Femur. Very slight lipping of condyles.

Bone 33. Right Scapula. Nothing of note.

Bone 34. Lower end of Right Humerus. Nothing of note.

Bone 35. Right Os Innominatum. Nothing of note.

Bone 36. Lower end of Right Femur. Nothing of note.

Bone 37. Half of a lumbar vertebra. Nothing of note.

Bone 38. Head of Femur. Nothing of note.

Bone 39. Lower end of Fibula. Nothing of note.

Bone 40. Lower end of Humerus. Nothing of note.

Bone 41. Lower end of Humerus. Nothing of note.

Bone 42. Lower end of Humerus. Nothing of note.

Bone 43. Lower end of Humerus. Small irregular cavity in the trochlea about 2 x 5 mm. in diameter. Walls are irregular, but not thickened.

Bone 44. Upper and Lower ends of Fibula. Nothing.

Bone 45. Upper end of Radius. Nothing of note.

Bone 46. Upper end of Fibula. Nothing of note.

Bone 47. Upper end of Fibula. Nothing of note.

Bone 48. Lower end of Fibula. Nothing of note.

Bone 49. Acetabulum. Nothing of note.

Bone 50. Humerus. Well marked changes of Type II arthritis in the upper joint, very slight in the lower. There is a large cavity in the head, approximately 1 cm. in diameter, with irregular but not thickened walls. It is located about 1 cm. from the joint line. The central marrow canal extends very high in the bone.

Nothing to see in the lower end.

Bone 51. Humerus. Well marked lipping in the upper joint. When the first slice, about 5 mm. thick, was sawn from the greater tuberosity, a small cavity about 5 mm. in diameter was discovered immediately beneath the cortical layer. The next section revealed the connection of this small cavity with a large cavity in the head of the humerus, located about 1 cm. from the joint line. This cavity has irregular walls, not thickened, and communicates with the central medullary canal. It is, therefore, an extension of the central medullary canal upward, to within 1 cm. of the joint.

Lower end of bone,—nothing.

Bone 52. Humerus. Slight lipping of the upper joint. Lower joint practically normal. The greater tuberosity contains a cavity about 1.5 cm. in diameter, the walls of which are comparatively smooth and regular, giving the cavity a spherical shape. The walls seem somewhat thickened. Another much smaller cavity, not communicating with the first, is present about 5 mm. medially to it. The central marrow canal does not extend higher than normal.

Lower extremity of bone,—nothing.

Bone 53. Humerus. Slight lipping of the upper joint. The central marrow canal extends up to within about 2 cm. of the shoulder joint, and in places even nearer to the joint than this. The bone trabeculae are very scant and are easily broken through.

Lower end,—nothing.

Bone 54. Humerus. Upper joint, slight lipping. Marrow canal extends upward to within about 2 cm. of the shoulder joint.

Lower end: The bone in the trochlea is soft, and breaks down easily, but this may possibly be from the age of the specimen.

Bone 55. Humerus. Practically normal.

Bone 56. Humerus. Upper end shows lipping and eburnation. Lower end possibly very slight lipping. Marrow canal extends to within about 1.5 cm. of the shoulder joint. An irregular communicating cavity carries it still nearer,—that is, to about 1 cm. from the joint.

Lower end of bone,—nothing.

Bone 57. Humerus. Upper end very slight lipping, lower end normal. Small irregular cavities in upper end of bone.

Bone 58. Humerus. Upper joint shows lipping. Lower end negative. Upper end of the bone contains a cavity under the great trochanter, with irregular, unthickened walls, not communicating with the marrow canal.

Lower end of bone negative.

Bone 59. Humerus. Very slight lipping of upper joint surface. On sawing, a cavity is found, about 1 cm. in diameter, fairly regular, directly under the trochanter, and within about 5 mm. of the joint. Central medullary canal does not extend upward higher than normal.

Lower end normal.

Bone 60. Humerus. Slight lipping of upper joint. Marrow canal extends up to within about 2 cm. of shoulder joint. A large cavity, not communicating directly with the marrow canal, about 1 cm. in diameter, occupies the great trochanter.

Bone 61. Tibia. Nothing of note.

Bone 62. Tibia. Nothing of note.

Bone 63. Tibia. Nothing of note.

Bone 64. Tibia. Both ends mouse-eaten, so that changes in joint surface cannot be determined. Upper end contains rarefied area about 1 x 1.5 cm., which has not reached stage of cavity formation.

Lower end negative.

Bone 65. Tibia. Negative.

Bone 66. Tibia. Negative.

Bone 67. Tibia. Negative.

Bone 68. Tibia. Negative.

Bone 69. Tibia. Negative.

Bone 70. Tibia. Upper end negative.

Lower end: Marrow canal comes down to within about 3 cm. of joint.

Bone 71. Tibia. Negative.

Bone 72. Tibia. Upper joint shows slight lipping. Nothing seen on sawing.

Lower end negative.

Bone 73. Upper end of Tibia. Negative.

Bone 74. Upper end of Tibia. Negative.

Bone 75. Tibia. Negative.

Bone 76. Tibia. Negative.

Bone 77. Tibia. The joint surfaces are too badly damaged to determine whether changes existed in them. Large cavity 2 cm. in diameter and about 1 cm. from joint, in head of tibia, from which the trabeculae are almost entirely absent. This cavity has no distinct wall, and appears to be simply caused by almost complete absorption of the bone trabeculae.

Lower end of bone: The marrow canal extends somewhat further than usual. The bone is evidently from a fairly young person, for the epiphyseal line is still distinctly visible.

Bone 78. Tibia. Negative.

Bone 79. Femur. Upper end: Moderate amount of lipping. Trabeculae in the neck of the bone are rather scanty, and break down easily on sawing, but there is no actual cavity.

Lower end: Lipping of joint margin. Area 5 mm. in diameter in the external condyle, in which the bone trabeculae are very scant and around which the bone is denser, as if to wall it off.

Bone 80. Femur. Nothing of note on gross inspection. One notes on sawing that the bone trabeculae of the head of the bone in its under portion, immediately adjacent to the joint, are very scant, as compared with those in the rest of the head.

Lower extremity: The internal condyle has been eaten away by mice. The external condyle shows lipping. Large cavity in bone about 5 cm. from the joint; but whether or not this is a post-mortem change, is impossible to say.

Bone 81. Femur. Upper end. Nothing of note. One notices on sawing the same scantiness of the trabeculae in the lower portion of the head near the joint as was observed in the last specimen.

Bone 82. Femur. Upper end: Slight lipping about margin of joint and bony excrescences on the great trochanter. One exostosis at summit of trochanter amounts to a small "spur." Well marked cavity about 1 cm. in diameter is present in the neck, and the marrow canal

extends somewhat higher than usual. One notices the same area of comparative rarefaction in the lower portion of the head noted previously. Lateral to it the dense lines of trabeculae spring from the cortex of the inner side of the shaft (or the under surface of the neck), and pass radiating upward to the joint. These are the trabeculae corresponding to the lines of strain. In other words, this area of spongy bone lies in a protected area just medially to the dense bone, just described. In this protected area there is little else but marrow.

Lower extremity: Moderate lipping. On sawing, nothing of note.

Bone 83. Femur. Upper extremity: Bony roughening on trochanter. One notes the same scarcity of trabeculae on the under portion of the head already mentioned.

Lower extremity: Mouse-eaten.

Bone 84. Femur. Negative.

Bone 85. Femur. Upper end: Breaks in cutting.

Lower end: Marked lipping.

Marked difference in density of the two condyles. Lateral condyle much denser than medial.

Bone 86. Femur. Upper end: Same rarefied area of trabeculae in head of bone before mentioned. The neck shows a well marked *calcar femorale.*

Lower end: Very slight lipping. Nothing worthy of note, on sawing.

Bone 87. Femur. Upper end: Mouse-eaten around head. The neck contains a cavity about 2 cm. in diameter, communicating with another smaller cavity below the great trochanter, and also with the central canal, which extends very high.

Lower end: Negative.

Bone 88. Femur. Upper end: Usual rarefied area is seen in lower portion of the head, another in the upper outer portion, and a third just above the attachment of the ligamentum teres. Wherever these rarefied areas are seen the bone over them is perforated for the entrance of blood-vessels.

Lower end: Marked lipping. Nothing of note on sawing.

Bone 89. Femur. Negative.

Bone 90. Femur. Slight lipping of head. Marked exostosis on greater trochanter. Neck contains cavity about 1 cm. in diameter, just above the *calcar femorale.* Same rarefied areas in upper and lower portion of head before noted.

Lower end: Negative.

Bone 91. Femur. Negative.

Bone 92. Femur. Upper end: Usual rarefaction of under portion of head is present. Area of rarefaction in neck, not amounting to a cavity, about 1 cm. in diameter.

Bone 93. Tibia. Upper end negative.

Lower extremity presents very small exostosis. Nothing on sawing.

Bone 94. Tibia. Negative.

Bone 95. Femur. Negative.

Bone 96. Acetabulum. Nothing of note.

Bone 97. Tibia. Negative.

Bone 98. Tibia. Negative.

Bone 99. Humerus. Negative.

Bone 100. Humerus. Negative.

Many of the specimens were in a poor state of preservation, and were badly broken or mouse-eaten, especially about the joint margins, so that their original condition could not be determined. It is possible, however, to draw a few definite conclusions from the material.

1. Changes peculiar to arthritis of Type II * (lipping of joint margin, exostoses about joint, eburnation) are very common.

2. Cavities in the bone near the joint are also very common. These cavities may be separate, they may communicate with the central marrow canal, or they may be merely extensions of the marrow canal to the vicinity of the joint. Usually the cavities possessed no definite, thickened wall. They seemed to have been caused by a more or less complete absorption of the bone trabeculae.

3. A certain connection seems to exist between 1 and 2. Cavities are most common in those bone ends which show changes of Type II arthritis. In the head of the humerus especially, when these changes are present, one can be fairly sure that sawing will reveal cavity formation.

4. The presence of an area of marrow with very little bone, in the under part of the head of the femur, explains the well known predilection of tuberculosis for this area as a starting place in hip-joint tuberculosis.

5. The head of the femur contains three small areas in which bone is scanty,—the one just mentioned, another about the insertion of the *ligamentum teres*, and a third in its upper part just lateral to the joint margin.

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* Type II Arthritis is a synonym for Nichols and Richardson's degenerative form, Goldthwait's hypertrophic form, the English osteo-arthritis, the German arthritis deformans, etc.

A STUDY OF THE STERNO-CLAVICULAR JOINT

By Leonard W. Ely

The material for this study was gained at autopsies conducted at Lane Hospital and at the San Francisco Hospital by the pathological department of Stanford University, and I take this opportunity to thank Dr. William Ophüls, professor of pathology, for his courtesy in supplying the material, as well as for his help in elucidating certain difficult problems which presented themselves.

The sterno-clavicular joint was chosen, because, although it presented a less promising field for study, it could be removed without mutilation. The joint was removed, and was sawn through antero-posteriorly. The quality of the marrow was noted, whether red or yellow, and any gross abnormalities. In many instances—invariably, in the later stages of the investigation—if the joint presented any evidence of abnormality, a section was taken from it, fixed in alcohol, decalcified in 5% nitric acid, run up through the alcohols, mounted in celloidin, and was stained with haematoxylin and eosin, and by the van Gieson method.

My material consists of ninety-one joints. The table contains certain facts about the cases gleaned from the autopsy records.

NOTES ON SPECIAL CASES

XVII, 58. The cartilages are somewhat roughened,—that is, as if they were blistered—but there are no erosions visible. Red marrow predominates in both bone ends. In the clavicle an area of yellow marrow is seen, which in one place approaches the cartilage near its periphery, but in another section is about 1 cm. removed from it. In the sternum a strip of yellow marrow runs down at one side of the section almost to the joint cartilage.

Histology.—The blisters can be identified as small irregularities, small projections, on the surface of the cartilage. The margin of the cartilage is composed of a strand of dense fibrous tissue. The bone and marrow beneath the cartilage appear normal.

XVII, 73. The marrow in the two bone ends is red and yellow in about equal parts, with the red predominating slightly. The joint appears normal, and the condition of the cartilage does not reflect the quality of the marrow.

Case No.	Sex and Age	Occupation	Duration of Disease	Blood Count		Cause of Death	Joint	Marrow	Abnormality in Bone or Cartilage
				Red	White				
XVII, 52	M 23	Dishwasher	....	4,000,000	14,000	Tuberculosis of intestines, liver, spleen, peritoneum, kidneys, lungs, lymph nodes, etc.	......	....	....
58	M 62	Attorney	3 wks., 1 day	....	....	Broncho-pneumonia. Cholecystitis. Cholecystotomy. Old pulmonary tuberculosis healed.	Cartilage slightly roughened.	Red and yellow in both, red predominates.	No
59	M 55	....	....	....	....	Broncho-pneumonia. Pyonephrosis. Nephrectomy.	Normal	Mixed in both, red predominates.	No
60	M 52	Engineer	....	4,000,000	3,300 to 10,000	Endocarditis, aortic insufficiency, splenic enlargement, nephritis. (Healed pulmonary tuberculosis.)	Normal	Red in both.	No
63	M 44	Electrician	1 yr.	Hgb. 5,000,000	60% 12,800	Carcinoma of stomach. Carcinoma metastasis. Broncho-pneumonia.	Normal	Red predominates in both, some yellow in both.	No
69	M 50	....	....	....	....	Broncho-pneumonia, cholelithiasis, nephritis. (Healed tuberculosis of bronchial lymph nodes.)	Normal (Rather thin cartilage.)	Both red.	No
70	M 70	....	....	....	....	Carcinoma of prostate, with metastasis in bladder, liver, pleura, lungs. Pyelitis, pyelonephritis, colitis, broncho-pneumonia, etc.	.....	Both yellow.	No
73	M 48	Teamster	8 mos.	....	....	Carcinoma of pancreas, with metastasis in liver, lymph nodes, etc. Ulcer of stomach. Hepatic cirrhosis.	.....	Red and yellow, red slightly more.	No
68	F 28	Domestic	1 yr.	2,700,000	14,000	Cystitis. Pyelitis. Lues(?). Nephritis. Broncho-pneumonia.	Normal	Red.	No
75	M ..	....	....	....	....	Lues of spinal cord. Fibro-sarcoma of left leg, with metastasis. Tuberculosis of lymph nodes (peri-bronchial). Emphysema. Broncho-pneumonia.	Thin cartilages, otherwise normal	Red, a thin streak of yellow in clavicle.	No No
80	M 32	Cook	2 yrs.	5,000,000	22,400	Diabetes. Tuberculosis of lungs. Pneumonia.	Normal	Red.	No

89	F 29	Housewife Social worker	....	4,000,000	....	Tuberculosis of peritoneum.	Normal	Red in both, a streak of yellow in sternum.	No
95	M 62	Laborer	....	....	....	Senility. Emphysema. Broncho-pneumonia, gangrene of lung. Pleurisy. Colitis (acute).	Roughened and thin cartilage.	Red and yellow mixed.	No
99	M 49	Furrier	....	....	....	Cystitis, chronic. Pyelitis, chronic. Lues (?) Abscess of kidney. Nephritis.	Normal	Red, some yellow.	Yes
91	M 32	Dentist	6 mos.	....	....	Dementia praecox. Broncho-pneumonia.	Normal	Red.	No
92	M 46	Laborer	7 wks.	....	....	Broncho-pneumonia. Gangrene of lung. Carcinoma of stomach. Metastatic carcinomata.	Normal	Red and yellow equal.	No
97	F 16	....	1 mo.	....	37,000	Vincent's angina. Pharyngitis (pseudo-membranous). Enteritis " " Laryngitis " " Vaginitis " " Broncho-pneumonia.	Normal	Red.	Yes
98	M 37	Laborer	6 mos.	4,550,000	5,700	Sarcoma of testis. Sarcoma of lymph nodes (metastatic). Metastatic sarcoma of left kidney. Broncho-pneumonia.	Normal	Red in both, but a streak of yellow in clavicle.	No
106	M 48	Cook	6 mos.	3,370,000	6,800	Carcinoma of larynx. Old tuberculosis of lung (healed). Broncho-pneumonia.	Normal	Red in both, but a triangle of yellow in sternum.	No
121	M 82	....	1 day	....	....	Broncho-pneumonia following fracture of femur. Taenia saginata.	Normal	Yellow in sternum, red and yellow in clavicle.	Yes
122	M 64	Laborer	7 days	....	14,000	Lobar pneumonia.	Normal	Red.	No
127	M 48	Cook	1 yr.	....	....	Carcinoma of stomach. Carcinoma metastasis. Acute peritonitis, following operation. Emphysema of lungs. Endocarditis. Broncho-pneumonia.	Normal	Red.	No
133	M 63	Waiter	....	4,500,000	14-15,000	Aneurysm of aorta. Arteriosclerosis. Lues. Chronic pleurisy. Emphysema. Cholelithiasis.	Normal	Mostly red, a little yellow in both bones.	No

Case No.	Sex and Age	Occupation	Duration of Disease	Blood Count Red	Blood Count White	Cause of Death	Joint	Marrow	Abnormality in Bone or Cartilage
XVII, 134	M 36	Laborer	2 yrs.	....	....	Pulmonary tuberculosis.	Normal	Red.	No
135	F 52	Housewife	15 yrs.	3,200,000	14,800	Lues of aorta, and valves with regurgitation. Hydrothorax.	Normal	Red in both, in clavicle yellow begins about 1 cm. from joint.	No
137	M 37	Wood-chopper	2 mos.	....	....	Carcinoma of liver. Carcinoma metastasis. Cirrhosis of liver. Acute nephritis.	Normal, but unusual in structure.	Red in both.	No
139	F ..	....	....	....	....	Septic abortion. Peritonitis. Oedema of lungs. Goitre, adenomatous. Aerogenes capsulatus infection.	Normal	Red.	No
145	M 30	Laborer	....	....	....	Old healed tuberculosis of lung. Chronic pleurisy. Thrombosis of heart. Embolism of pulmonary artery. Chronic nephritis.	Normal	Red.	....
146	M ..	....	5 days.	....	....	Incarcerated hernia. Enterotomy. Chronic pericarditis. Acute peritonitis. Broncho-pneumonia. Arteriosclerosis. Carcinoma of prostate. Acute pleurisy.	Normal	Yellow except for a small streak under cartilage and at sides in both bones.	
147	M 28	Kitchen helper	....	....	....	Tuberculosis of lungs, chronic, healed. Tuberculosis of adrenals. Addison's disease. Bronchitis, acute.	Normal, but unusual in structure.	Red.	No
148	F 36	Housewife	1 mo.	3,000,000	5,000	Carcinoma of bronchus. Metastatic carcinoma of lymph nodes, thyroid gland, liver kidney, etc. Abscess of left lung.	Normal	Pale red.	No
149	M 24	Box-maker	4 mos.	3,100,000	39,600	Acute bronchitis. Tuberculosis of intestine, lymph nodes, spleen, etc. Chronic endocarditis, nephritis and myocarditis.	Normal	Red in both predominates, but some yellow is present.	Yes

153	M 57	Miner	....	4,400,000	18,100	Bronchiectasis. Embolism of pulmonary artery. Infected infarct of lung. Chronic suppurative pleurisy. Thrombosis of heart. Necrosis of liver.	Normal	Red and yellow in clavicle, red in sternum.	No
155	M 41	Lead worker	....	3,000,000	15,000	Carcinoma of stomach. Metastatic carcinomata. Acute cholangioitis. Abscess of liver. Collibacillosis. Acute pleurisy. Broncho-pneumonia.	Thin cartilage over clavicle.	Red.	No
156	F 43	....	7 mos.	....	....	Arteriosclerosis. Acute nephritis. Acute hepatitis. Broncho-pneumonia.	Normal	Yellow predominating in both.	No
157	M 71	Laborer	2 wks.	4,500,000	6,200	Arteriosclerosis. Chronic splenitis. Chronic hepatitis. Pulmonary emphysema. Hydrothorax and ascites.	Normal	Red and yellow in about equal parts.	No
161	M 38	Real estate	2½ yrs.	....	....	Lymphosarcoma of mediastinum. Metastatic lymphosarcomata.	Normal	Red.	No
164	M 61	Cook	20 ?	3,500,000	14,600	Gout. Arteriosclerosis. Broncho-pneumonia. Chronic pleurisy.	Normal	Red.	No
167	M 44	Laborer	2 mos.	2,400,000	44,000	Carcinoma of gall bladder.	Thin cartilage over clavicle.	Red.	Yes
169	M 49	Laborer	....	....	....	Tabes. Bronchiectasis. Abscess of kidney. Pyelitis, cystitis. Broncho-pneumonia.	Normal	Red.	No
171	M 64	....	....	....	....	Leprosy. Broncho-pneumonia. Arteriosclerosis. Cholelithiasis.	Normal	Red in clavicle, red near the joint, yellow further in, in sternum.	No
174	F 50	....	3 mos.	1,600,000	15,000	Carcinoma of pancreas. Metastatic carcinomata. Abscess of liver.	Normal	Red.	No
175	M 47	Contractor	1 mo.	....	....	Gangrene of lung. Carcinoma.	Normal	Red.	Yes
179	M 67	Laborer	....	4,000,000	11,000	Arteriosclerosis. Ascites. Hydropericardium. Hydrothorax.	Normal	Red.	Yes
XVIII, 2	M 48	Salesman	1 yr.	1,024,000	6,000	Pernicious anaemia.	Normal	Red.	No

Case No.	Sex and Age	Occupation	Duration of Disease	Blood Count		Cause of Death	Joint	Marrow	Abnormality in Bone or Cartilage
				Red	White				
XVIII, 4	M 37	Butcher	....	....	....	Syphiloma of brain. Broncho-pneumonia. Parenchymatous goitre.	Normal	Red in sternum, little marrow of any kind can be seen in clavicle.	Yes
10	M 45	Laborer	6 wks.	....	....	Chronic ulcer of stomach, with perforation of splenic artery. Emphysema. Chronic pleurisy.	Normal	Pale red.	No
13	M 50	Farmer	....	....	....	Malaria. Otitis media, acuta. Operation, mastoid. Septicaemia.	Normal	Red.	No
15	M 64	Salesman	....	....	10-12,000	Tuberculosis of lungs, healed, chronic; of adrenals, kidney, bladder, testis, vas deferens. Addison's disease.	Normal	Red with a little yellow.	Yes
18	M 40	Solicitor	....	....	10,000	Syphilis of meninges, cerebral. Syphiloma of brain. Broncho-pneumonia. Syphilis of aorta.	Normal	Red and yellow in both.	Yes
23	F 65	....	....	....	....	Intestinal obstruction. Broncho-pneumonia.	Normal	Red.	No
25	M 2	....	....	....	....	Diphtheria. Broncho-pneumonia.	Normal	Red.	No
32	M 48	Kitchen helper	....	....	....	Syphilis of aorta. Syphilis of skin. Aneurysm of arch of aorta.	Normal	....	Yes
31	F 30	....	....	1,064,000	50,000	Haemorrhage into peritoneum. Abscess of pelvis. Anaemia, secondary progressive.	Normal	Red.	No
43	.. ..	....	....	....	....	Diphtheria. Broncho-pneumonia.	Normal	Red.	No
44	F 35	Prostitute	....	....	21,000	Tabes dorsalis. Pelvic peritonitis, chronic. Cystitis, acute. Pyelitis, acute. Endocarditis, chronic.	Normal	Red in sternum, mixed in clavicle.	Yes
45	M 28	Laborer	....	4,000,000	....	Endocarditis, chronic. Aortic regurgitation. Aortitis, chronic ulcerative. Broncho-pneumonia.	Normal	Red.	No

46	M 60?	....	10 dys.	....	24,000	Cellulitis. Septicaemia. Endocarditis. Erysipelas.	Normal	A little yellow in clavicle. Red.	No
50	F 59	....	....	....	....	Carcinoma of sigmoid flexure. Endocarditis, chronic. Pericarditis. Emphysema.	Normal	Red.	No
56	M ..	Teamster	....	....	....	Bronchitis, acute. Broncho-pneumonia. Alcoholism, acute (?). Pellagra, acute (?).	Normal	Red and yellow.	Yes
57	M 62	Laborer	....	....	....	Arteriosclerosis, general. Embolism of pulmonary artery with infarcts in lung.	Normal	Red and yellow.	Yes
58	M 79	....	....	4,900,000	21,200	Endocarditis, chronic. Pericarditis, acute. Broncho-pneumonia. Pleurisy, serofibrinous. Septicaemia. Arteriosclerosis of aorta.	Normal	Red.	No
60	M 37	Laborer	....	....	....	Sarcoma of liver, primary. Embolism. Metastatic sarcomata. Periotoneum, haemorrhage into.	Normal	Red and yellow, yellow most.	Yes
?	.. ..	....	....	....	....		Abnormal	Red.	Yes
70	M 53	Laundry-man	....	....	....	Tonsillitis, pseudo-membranous. Stomatitis " " Pharyngitis " " Nephritis, chronic.	Normal	Red and yellow.	Yes
71	M 9	School	5 dys.	....	....	Glossitis. Tonsillitis. Broncho-pneumonia.	Normal	Pale red.	Yes
72	M 39	Plumber	1½ yrs.	....	14,000	Carcinoma of bronchus. Metastatic carcinoma of brain.	Normal	Red, with small amount of yellow.	Yes
75	M 42	Domestic	4-5 yrs.	....	5,500	Tuberculosis of lung, chronic; of prostate, meninges, kidneys.	Normal	Deep red.	No
76	M 42	....	....	4,600,000	7,800	Asthma. Broncho-pneumonia. Nephritis, chronic. Tuberculosis of mesenteric glands, healed.	Normal	Red in both.	No
77	F 70	....	....	....	13,000	Arteriosclerosis, general and cardiac hypertrophy. Arteriosclerosis, local, of coronary. Thrombosis of right auricle. Embolism of pulmonary artery. Aneurysm of heart.	Normal	Red predominates, but yellow in both.	No
78	M 61	Laborer	3 wks.	....	20,000	Nephritis, chronic. Arteriosclerosis. Gout. Embolism of pulmonary artery with haemorrhagic infarction of lung.	Normal	Red in both.	No

Case No.	Sex and Age	Occupation	Duration of Disease	Blood Count		Cause of Death	Joint	Marrow	Abnormality in Bone or Cartilage
				Red	White				
XVIII, 83	M 20	Janitor	....	....	....	Tuberculosis of lymph nodes, peribronchial. Tuberculosis of cerebro-spinal meninges. Cystitis, acute.	Normal	Red.	No
84	M 64	Bedmaker	....	....	....	Endocarditis, chronic. Broncho-pneumonia. Pleurisy.	Normal	Red and yellow in both.	No
85	M 22	Waiter	7 mos.	....	....	Tuberculosis of lungs, chronic; of intestines, lymph glands. Pleurisy, chronic.	Normal	Red in sternum, red and yellow in clavicle.	No
86	M 64	Long-shoreman	....	....	....	Tuberculosis of lungs, chronic, healed. Emphysema of lungs. Nephritis, chronic. Arteriosclerosis, general. Pleurisy, chronic.	Normal	Red and yellow in both.	Yes
87	M 50	Painter	1 mo.	3,280,000	22,600	Cirrhosis of liver. Broncho-pneumonia. Endocarditis, acute, pulmonary.	Normal	Red and yellow.	No
90	M 50	Miner	12 yrs.	....	....	Carcinoma. Operation, enucleation of eye. Carcinoma, metastasis. Meningitis, acute. Tuberculosis of lungs. Bronchitis, acute purulent. Broncho-pneumonia. Syphilis of aorta, healed.	Normal	Red in clavicle, red and yellow in sternum.	No
92	M 33	Bookkeeper	....	....	....	Operation, appendectomy, drainage of liver abscess. Pneumonia, lobar. Dysentery, entabnetic (?). Abscess of liver, healed.	Normal	Red.	No
99	M ?	....	3 mos.	....	....	Broncho-pneumonia. Pellagra (?). Dysentery, ulcerative.	Normal	Red in clavicle, red and yellow in sternum.	No
100	M 70	....	....	....	....	Tuberculosis of lungs, healed; of lymph nodes, of mesenteric nodes, chronic; of retroperitoneal, intestine, meninges; acute general.	Normal	Red.	Yes

101	M 26	....	....	....	....	Chronic osteomyelitis of lumbar spine. Abscess. Psoas. Sup. nephritis. Multiple abscesses of lungs. Bronchiectasis. Amyloid of spleen.	Normal	Red.	No
103	M 50	Peddler	5 mos.	....	10,800	Carcinoma of bile duct, hepatic duct. Streptococcic cholangitis. Cirrhosis. Carcinoma of oesophagus. Bronchitis, acute. Broncho-pneumonia.	Abnormal	Red and yellow.	Yes
105	M 6	....	....	....	....	Diphtheria. Tracheotomy, pressure necrosis. Trachea, perforation of. Cellulitis of neck. Broncho-pneumonia. Trichiasis.	Normal	Red.	No
106	F 27	Housewife	3 wks.	....	10-15,000	Nephritis, glomerular, subacute. Cystitis, acute. Erysipelas. Broncho-pneumonia.	Normal	Red.	No
107	F 3	....	....	....	....	Diphtheria. Angina Ludovici. Septicaemia; endocarditis, acute. Infarcts of kidney. Infarct of spleen. Broncho-pneumonia. Tuberculosis of peribronchial lymph nodes, healed.	Normal	Red.	No
112	F 64	....	27 yrs.	....	....	Operation, myomectomy. Arteriosclerosis, general. Nephritis, arteriosclerosis, chronic. Broncho-pneumonia, terminal.	Normal	Red in sternum, red and yellow in clavicle.	Yes
114	M 38	....	....	....	....	Tabes dorsalis. Broncho-pneumonia.	Normal	Red.	No
115	F 25	....	....	....	....	Cyst. of broad ligament. Peritonitis, acute, general. Peritoneum, haemorrhage into. Abscess of liver, healed. Mole, pigmented.	Normal	Red.	No
117	F 45	Housewife	....	....	....	Tabes dorsalis. Chronic cystitis. Pyelitis, chronic. Pyelonephritis, acute. Bladder, perforation of. Peritonitis. Salvarsan, ill effects of. Arsenical poisoning, acute. Colitis, ulcerative.	Normal	Red.	No
119	M 36	....	9 mos.	....	....	Endocarditis, chronic. Pneumonia, lobar. Tuberculosis of lungs, healed. Infarction of kidney, old.	Normal	Red.	No
120	.. ..	....	....	....	....		Normal	Red.	No

XVII, 75. At one side of the joint the clavicular cartilage is rather rough, and looks degenerated and thin. On the other side it is rather thick. Where the thin cartilage begins, there the interarticular cartilage is split across so that it can be lifted off. A similar condition is present over the cartilage of the sternum. The marrow of both bones is red, except for a thin streak of yellow down one side of the clavicle.

XVII, 95. The cartilage over the end of the clavicle is thin and roughened. The marrow in this bone is about an equal mixture of red and yellow. In the sternum the red predominates.

XVII, 99. The joint is perfectly normal, the cartilages are intact. A section shows the following very peculiar condition of the bone: On one side of the section the marrow in both bones is almost entirely red. At one spot in the clavicle is a small area of yellow marrow. Near it is a small cavity about 3 mm. in diameter, and shaftwards from this the bone is soft and pulpy. On the other side of the section the yellow area is much larger, and a bar of dense bone on the shaft side runs partly across the clavicle about 1.5 cm. from the joint. The bone on the shaft side of this bar is pulpy. One fragment of the clavicle from which the section was taken shows the other half of the cavity with a pulpy area about it. The other fragment shows a yellow streak of bone and marrow.

HISTOLOGY.—The cavity in the bone is easily identified. It is lined by marrow and has no distinct fibrous wall. Throughout the slide, and especially in the pulpy portion, engorged blood-sinuses form a prominent feature. The pulpy part contains but a few scattered trabeculae.

XVII, 98. Red marrow in both bones, except for a streak of yellow running down one side of sawn surface of clavicle.

XVII, 106. Red marrow in both bones, except for a triangle of yellow just below the cartilage under the periosteum of the sternum.

XVII, 121. The interarticular fibro-cartilage has disappeared except for a "glenoid" ligament about the circumference. The cartilages are thin, but the joint surfaces are normal. Yellow marrow in sternum, red and yellow patches in clavicle. In the clavicle, about 8 mm. from the cartilage, the bone has undergone softening, and the marrow is pulpy in an area approximately 1 cm. in diameter.

HISTOLOGY.—The cartilages present the characteristic features of an arthritis of Type II—the gathering of the cells in groups, the peculiar fibrillation of the basement substance, the tattering of the cartilage, and its bizarre appearance. Underneath the cartilage is an irregular layer of osteoid tissue. The subjacent marrow is partly lymphoid and partly

fatty. The lymphoid marrow contains many engorged blood-vessels and blood-sinuses. In the sternum, immediately beneath the level of the cartilage but not completely covered by it, is a "focus" of dense fibrous tissue fairly well surrounded by bone trabeculae, and communicating with the joint. There is another "focus" about 1 mm. from the first, away from the joint, which may be an irregular prolongation of it, caught at an angle by the knife. There are also two or three small "foci" in the clavicle near the cartilage, and strands of fibrous tissue deep in the marrow. The pulpy area mentioned above consists of fatty and lymphoid marrow, engorged with blood, and containing only a few small bone trabeculae.

XVII, 133. This joint presents indications of an interarticular ligament between the clavicle and the interarticular fibro-cartilage. Red marrow throughout, except for a small mass of yellow in the anterior portion of the clavicle, and a smaller one in the anterior portion of the sternum.

XVII, 146. Yellow marrow throughout, except for a streak of red about 3 mm. broad, directly under the clavicular cartilage and under the bone along one side, and another thinner streak on the sides and end of sternum.

Histology.—The areas of red marrow mentioned in the gross inspection can be identified easily. In them can be seen many blood-sinuses filled with blood. These sinuses have no well defined vessel-wall, but look like currents of blood washing through the marrow.

XVII, 149. Red marrow predominates, but yellow is present in both bones. The section of the clavicle at autopsy went through what appears to be a fibrous "focus," filling in a large part of the space between the layers of cortical bone. The "focus" is mostly in the posterior portion of the clavicle, and has perforated the shell of bone there, communicating thus with the outside.

XVII, 155. Red marrow in both. The cartilage over the clavicle is very thin, and this thinness in one place is so marked as to amount almost to an erosion. The bone looks normal.

XVII, 167. Red marrow throughout. The cartilage of the clavicle is very thin and slightly eroded. Only a trace of interarticular fibro-cartilage is present. About 1.5 cm. from the cartilage is a cavity in the bone, through which the autopsy cut has gone. This cavity is filled with a deep red, semifluid material, which looks liks red marrow. The cortex is much thickened about this cavity, but no actual bony wall separates it from the spongy bone jointwards.

Histology.—The cartilage varies in its thickness. Over one half it is very thin, over the other of about normal thickness. Its thin part resembles hyaline cartilage more than fibro-cartilage. "Fingers" of marrow are pushing up into it. The trabeculae stain irregularly, and seem to be undergoing absorption, but not by osteoclasts. They cease almost entirely about 1 cm. from the joint.

XVII, 175. Normal joint. Red marrow in both bones. In the clavicle are reddish, irregular, rather firm areas of what appears to be fibrous tissue, from which all bone has disappeared. In the sternum at about 1 cm. from the joint begins an area of yellowish, fairly tough fibrous tissue, which takes up the entire space between the layers of cortical bone. It also contains no bone.

Histology.—Well-marked carcinoma. The nodules are composed of fibrous tissue and epithelial cells, and infiltrate the surrounding healthy marrow.

XVII, 179. Normal joint. Red marrow in both bones. In this, as in the preceding specimen, the spongy bone of the clavicle at a distance of about 1 cm. from the joint disappears, and is replaced by a soft pulpy mass of what appears to be yellow marrow, filling the entire area between the layers of cortical bone.

Histology.—Pulpy area identified. It consists of densely packed marrow cells, of "myxomatous" marrow, and of a few small trabeculae.

XVIII, 4. The bone in the clavicle seems much denser than normal. The marrow canal is filled with bone only slightly less dense than the thick cortical bone. There is little else but dense bone in the clavicle —just a little dense, spongy bone in the immediate vicinity of the joint and in small patches elsewhere. The cortex is enormously thickened, and bulges out at one spot about 2 cm. distant from the joint. The sternum contains red marrow. The joint is normal.

Histology.—There is a great increase of bone throughout the clavicle. The trabeculae are enormously thickened. Very little of a cortex with its regular arrangement exists. The cortex is formed by the thick trabeculae, among many of which the fibrous tissue passes down from the periosteum into the marrow. The marrow is mostly fibrous. The bulging of the cortex noted macroscopically consists of dense fibrous tissue replacing the cortex, and the bone and marrow beneath it. The marrow of the sternum is lymphoid.

XVIII, 15. Red marrow throughout, except for a small transverse band of yellow in the clavicle about 1 cm. from the joint, and a small patch of yellow in the sternum a short distance from the joint

near the cortex. There is also a patch of red pulp in the sternum about 1 cm. from the joint.

HISTOLOGY.—The pulp is seen to consist of lymphoid marrow with a few small trabeculae.

XVIII, 18. Joint appears normal. The marrow in the sternum is in two longitudinal bands, red and yellow, the red the broader. In the posterior part of the clavicle the red marrow appears as a triangular area beneath the cartilage. The rest of the marrow is yellow. Beginning at a spot about 1 cm. from the joint-line the posterior cortex of the clavicle is replaced by a dense, soft tissue of the consistency of felt.

HISTOLOGY.—On one side of the section the cortex is very thin near the joint, and is broken through at intervals, so that the periosteum communicates with the marrow. At a short distance from the joint the bone cortex ceases entirely, and the fibrous tissue of the periosteum streams into the marrow (or the reverse). The cortex does not begin again for a distance of about 2 cm. from the joint. All about the fibrous tissue the bone trabeculae are greatly thickened. In the fibrous tissue is a small area of calcified, necrotic material. The cartilage shows a marked variation in thickness. One half is thin, the other thick. The thin cartilage covers bone with fatty marrow, the thick cartilage bone with lymphoid marrow.

The specimen appears to be an example of an old infectious process in the bone, with destruction of the cortex, and a production of fibrous tissue in the marrow. Possibly the process is traumatic, and the necrotic material has been carried in from the outside.

XVIII, 32. The marrow is mostly red. The clavicle contains a patch of yellow marrow about 5 mm. in diameter, about 1 cm. from the joint. Between this patch and the joint the bone trabeculae seem scant, and are replaced by areas of soft, red material. Shaftward the bone seems thickened.

HISTOLOGY.—The area of yellow mentioned in the gross examination consists of yellow marrow, with small, scanty bone trabeculae; the red area, of lymphoid marrow with few trabeculae, and of yellow marrow greatly engorged. In places the bone trabeculae are thickened, and to some of these trabeculae masses of fibrous connective tissue are attached, in which calcification is going on. Running along the margin of other trabeculae are bundles of connective tissue partly ossified. Ossification seems to be proceeding, in other words, through the medium of fibrous connective tissue. There is no evidence of new formation of bone by osteoblasts. The cortex is re-enforced in places by small masses

of bone on its inner aspect, which show a marked affinity for haematoxylin.

No. 54 (autopsy number unknown). Normal joint. Very red marrow. Section shows a thickening of the bone beginning about 1.5 cm. from the joint-line, on the anterior aspect. On one side of the section the thickening shows as an increase of the cortex, on the other as a diffuse thickening of the spongy bone.

HISTOLOGY.—The joint is not normal. Tracing in from one side of the joint, we find a rather thin cartilage, with almost the appearance of hyaline cartilage, covered by a layer of fibrous tissue, which evidently has spread in from the circumference. Then comes a short, depressed area of cartilage, covered by fibrous tissue. Adjacent to this is an excavation in the end of the bone, filled with fibrous tissue and fibro-cartilage. At the far side of this again, a thick layer of fibrocartilage begins, and continues to the other side of the joint. The diffuse thickening of the bone noted in the macroscopical examination is caused by a large number of thick trabeculae, enclosing lymphoid marrow. In this marrow are many large, engorged blood-vessels. The marrow is mostly lymphoid, and is markedly engorged.

XVIII, 44. Red marrow in the sternum. In the clavicle the marrow near the joint is red, farther away it is red and yellow in patches. Beginning about 1 cm. from the joint is a patch, about 5 mm. in circumference, of yellow marrow, in which the trabeculae seem very scanty, and the bone soft.

HISTOLOGY.—The microscopic appearance confirms the macroscopic. No definite disease is evident. The marrow is mostly fatty, and the scanty small trabeculae appear to be undergoing absorption, but not by osteoclasts.

XVIII, 57. The joint is normal. Red marrow predominates, but yellow areas appear in both bones. In the clavicle the spongy bone ceases at a distance of about 1 cm. from the cartilage, and the entire space within the shell of dense bone is filled with a reddish pulp.

HISTOLOGY.—The areas of fatty and of lymphoid marrow are evident. The pulpy area is seen to consist of fatty and lymphoid marrow, with very few, small trabeculae. The cartilage is irregular in its structure and in its staining. Its cells are arranged in groups, and its free border is "tattered"—as in Type II chronic arthritis.

XVIII, 56. Red and yellow marrow is mixed in the two bones, about equally as to area. The joint appears free from disease, but is peculiar in construction. Instead of the usual shape of the end of the

clavicle, and an interarticular fibro-cartilage with a joint cavity on either side of it, the end of the clavicle is deeply concave, and is filled with fibrous tissue in the concavity. This fibrous tissue represents the clavicular joint and the fibro-cartilage; that is, there is but one joint cavity. About 5 mm. from the deepest part of the clavicular end the bone trabeculae seem to be sparse, and the spongy bone is mere pulp.

The microscopical examination confirms the macroscopical.

XVIII, 60. Red and yellow marrow mixed in both bones, yellow predominating. The cortex of the clavicle is very thick.

HISTOLOGY.—The section of the sternum shows well the impossibility of drawing a sharp line of distinction between marrow and periosteum. On the outside of the cortex, but beneath the fibrous tissue of the periosteum, are small pockets of marrow.

No. 60 (autopsy number unknown). Red marrow throughout. The clavicle is greatly increased in size, out of all proportion to the sternal piece. Both cartilages seem thin. That over the clavicle is rough, and somewhat eroded at its center.

HISTOLOGY.—Sternum. At one side of the section, granulation tissue is pushing its way under the cartilage. Nearer the center, granulation tissue is pushing up through the cartilage from the subjacent marrow. The cartilage varies in thickness, and is more or less irregular in outline. A few vessels with thickened walls are present in the marrow.

Clavicle. The marrow is lymphoid, but contains here and there islands of fibrous tissue, some of which apparently is being transformed into bone. The line of demarcation between the bone trabeculae and the fibrous tissue is shown by a moderately thin line of calcification. Underneath the cartilage the marrow is fibrous, and pushing up into the cartilage from below at fairly regular intervals are small "fingers" of new connective tissue, some of which contain typical myeloplaxes.

XVIII, 70. Normal joint. Yellow and red marrow in about equal proportions in both bones. Where yellow marrow is, there the bone is soft.

HISTOLOGY.—The red and yellow marrow are very "patchy" in their arrangement. Where the yellow is, there generally the bone trabeculae are few in number. This section shows well the error of a sharp division between marrow and periosteum. Here and there on the *outside* of the cortex are small depressions or "pockets" containing marrow.

XVIII, 71. The specimen is a child's joint, normal. The marrow is pale red in both bones. Near the joint the marrow of the clavicle is of a deeper red. Immediately under the clavicluar cartilage, near the side

of the section, is a soft, red, pulpy area, about 3 mm. in diameter, without bone.

HISTOLOGY.—The marrow throughout most of the section is largely of a "fibro-myxomatous" character. The softened area, mentioned above, is seen to consist of fibrous and fibro-cartilaginous tissue. Many typical osteoclasts can be seen in their Howship's lacunae. The cortex in places is not a real layer of dense bone, but consists of lamellae with a somewhat longitudinal arrangement.

XVIII, 72. Normal joint. Red marrow in sternum. Red marrow in the clavicle near the joint, but at a distance of about 1 cm. from the joint the red changes to yellow, and farther still from the joint a softening appears.

HISTOLOGY.—The marrow at the site of the softening noted above appears normal, but the bone trabeculae have disappeared from it.

XVIII, 85. Red marrow in sternum, and in the clavicle with the exception of a patch of yellow about 2 cm. from the joint. The cortex on one side of the clavicular section is thickened, and presents a slight bulge at one spot. The joint is normal, but the deep surface of the clavicular cartilage is irregular.

HISTOLOGY.—The cortex on one side of the section is markedly thickened, beginning at a point about 3 cm. from the joint-line. In one place, over the bony thickening, the periosteum is absent, and its place is taken by cartilage, whose cells are arranged in large groups. Ossification evidently is taking place in the deep portion of this cartilage, and apparently this is the method of bone production which is responsible for the bony thickening, for cartilage cells can be distinguished over the entire exostosis, at times under the fibrous periosteum, at times in it. The deeper cells of the articular cartilage are in large groups, which stain deeply with haematoxylin. The cartilage looks like that of arthritis of Type II, and apparently is undergoing ossification in its deep portion. Its under aspect is extremely irregular. The trabeculae in the vicinity contain cartilage cells, and even at a distance from the joint, islands of cartilage can be seen in the marrow. This evidently is a case of endochondral ossification, within and without the bone.

XVIII, 86. The joint is normal, but the cartilage on the clavicle is very thin. Red and yellow marrow in the sternum, the yellow predominating. The marrow in the clavicle is red. In the clavicle, about 2 cm. from the cartilage, is a paler area, running up to the line of postmortem section, where it is yellow. In places this area contains bone, but for the most part it is pulp. The cortex on one side is thickened. (The section was completely decalcified in four days.)

Histology.—The pulpy area in the clavicle consists of fatty marrow, from which the bone has practically disappeared. The marrow near the joint is normal lymphoid, and here the trabeculae are normal in size and in number.

XVIII, 100. Normal joint. Deep red marrow throughout both bones. In the clavicle at a distance of about 1 cm. from the joint, the bone trabeculae practically cease, and the whole shaft is filled with a pulp-like mass. The same condition to a lesser extent is present in the sternum, but nearer the joint. The bone cuts very easily. The specimen decalcified in forty-eight hours.

Histology.—Clavicle. The marrow shows a very early stage of tubercle formation. Small typical tubercles are scattered here and there, some of them beginning to coalesce. *They are located in otherwise apparently normal lymphoid marrow* near the joint, not in the pulpy area farther away, described above. The bone trabeculae in their vicinity are normal, the joint also. The pulpy areas consist of lymphoid and of fatty marrow, from which the trabeculae have almost disappeared. The marrow contains perhaps a superabundance of endothelial leucocytes. The sternum also contains a very small focus directly under the cartilage, in the lymphoid marrow—aggregated tubercles, with beginning cheesy degeneration,—and one some distance from the joint, also in lymphoid marrow. The marrow is exclusively lymphoid, except for a small area of fatty marrow at a distance from the joint. Slides stained by the Ziehl method show tubercle bacilli.

XVIII, 103. Red marrow predominates in both bones, but some yellow is present. The cartilage over the sternum is thin and irregular.

Histology.—The thin and irregular sternal cartilage is manifest. The marrow directly beneath it is engorged with blood, and in places is pushing up "fingers" into the cartilage.

XVIII, 112. The joint is normal. The marrow in the sternum is red, in the clavicle red and yellow. From one area in the clavicle, about 5 mm. in diameter, the bone trabeculae have almost disappeared, and the marrow is so much pulp.

Histology.—The area of pulp is seen to consist of yellow marrow, in which are a very few small bone trabeculae. On one side of the section the layer of cortical bone is extremely thin; in fact for a short distance it ceases entirely. The periosteum over this thin cortical bone is normal near the joint, but becomes much thicker farther away, so as to form a thick mass of fibrous tissue. Many cartilage cells are seen in the periosteum, so that in places it is fibro-cartilage.

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A Study
of the
Magmatic Sulfid Ores

BY

C. F. TOLMAN, JR.
Associate Professor of Economic Geology

and

AUSTIN F. ROGERS
Associate Professor of Mineralogy and Petrography

With 20 Plates and 7 Text Figures

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A STUDY OF THE MAGMATIC SULFID ORES

INTRODUCTION

Definition of Magmatic Ores

The term "magmatic ore" is generally applied to those phases of igneous rocks in which there has been an unusual accumulation, supposedly during the molten stage, of the accessory ore-minerals. The recognition of this type of ore deposits is due largely to the work of Vogt, who, in a classic series of papers,[1] not only established the existence of magmatic ores, but also arranged them into well defined groups, and gave the characteristics of each group. His classification has been followed generally by the authors of recent textbooks.[2] Nevertheless some confusion is apparent in geological literature as to the meaning of the term "magmatic" as applied to ore deposits. This is due in part to the designation[3] of all deposits of direct or indirect magmatic origin as magmatic deposits. For example, few doubt the magmatic origin of contact deposits and of cassiterite-tourmaline-quartz veins; but these are not magmatic deposits or segregations in the strict sense of the term.

The term "magmatic deposits" should be limited to those segregations of ore-minerals that take place under the influence of, or closely connected with, the molten stage of the parent rock. Ore accumulations accompanied by destructive pneumatolytic action, or those formed by hydrothermal solutions, are not to be classed as magmatic deposits, altho they may be closely related to, and follow, the magmatic period

[1] Vogt, J. H. L.—Bildung von Erzlagerstätten durch Differentiationsprocesse in basischen Eruptivmagmata. Zeit. f. prakt. Geol., Jahrgang 1893, 4-11, 125-43, 257-284.

——Beitrage zur genetischen Classification der durch magmatische Differentiation-processe und der durch Pneumatolyse entstanden Erzvorkommen. Zeit. f. prakt. Geol., Jahrg. 1894, 381-399.

——Weitere Untersuchungen über die Ausscheidungen von Titaneisenerzen in basischen Eruptivgesteine. Zeit. f. prakt. Geol., Jahrg. 1900, 233-242, 370-382; Jahrg. 1901, 9-19, 180-186, 289-296, 327-340.

[2] As is noted below, Vogt classifies as magmatic certain pyritic deposits that we believe should not be included in the magmatic group, and also omits one of the most important divisions of this group, viz., the chalcopyrite-bornite type of magmatic ores.

[3] Geijer, Per.—Iron-ore geology in Sweden and America. Econ. Geol., **10**, 231 (1915).

of ore concentration. In as much as ore concentrations connected with persilicic ("acid") rocks are of the latter type, the typical magmatic deposits are confined to the subsilicic ("basic") rocks.

Theories as to the Segregation of Magmatic Ores

Altho the chief types of magmatic ores are well recognized, there is considerable difference of opinion as to the details of the processes by which the ores are formed, and as to the "order of crystallization" of the ore-minerals with reference to the silicates. These different ideas may be grouped broadly as follows:

1. Magmatic ores have been defined as unusual accumulations of certain of the accessory minerals of the igneous rocks; and as the accessory minerals are generally believed to be the first to crystallize out of the magma, according to the order of crystallization suggested by Rosenbusch, the natural inference is that the ores are the first to form, and that they settle by gravity to the base of the magma. For example, it is generally assumed that the segregation of the large bodies of iron ore in the Bushveldt laccolith in South Africa and in the Duluth laccolith and the sulfid masses in the Sudbury laccolith have been controlled by gravity.[4]

Beyschlag, Krusch, and Vogt[5] state "Bei den meisten Eruptivgesteinen beginnt die Kristallisation mit der Aussonderung der sogenannten Erzmineralien, wie Magnetit oder Titanomagnetit, Eisenglanz, Ilmenit, Zirkon, Apatit, Schwefelkies, mitunter auch Spinel u. s. w. In einer etwas späteren Stufe der Verfestigung beginnen die Eisenmagnesiumsilikate, wie Glimmer, Hornblend, und Pyroxenmineralien und Olivin, zu kristallisieren."

2. Vogt, who has examined the magmatic ores both in the field and with the microscope, favors the hypothesis that prior to the crystallization of the rock-minerals the ores separate as an immiscible sulfid or oxid melt, which continues in the molten state during the consolidation of the silicates, intrudes the latter, and finally crystallizes.

3. Modern investigation of polished surfaces of ores has led to the discovery that the magmatic sulfid ore-minerals have a definite order of crystallization, and that the younger minerals intrude and replace the older. To meet this, Howe has framed a modification of Vogt's hypothesis. He suggests[6] that the different minerals which make up the sulfid

[4] Daly, R. A.—Igneous rocks and their origin, 454 (1914).

[5] Die Erzlagerstätten der Nutzbaren Mineralien und Gesteine, 1, 240 (1910).

[6] Howe, E.—Petrographical notes on the Sudbury nickel deposits. Econ. Geol., 9, 522 (1914).

matte are mutually immiscible, and the sulfids last to crystallize intrude the previously solidified sulfids.

4. Our study of the magmatic ores has led us to frame the hypothesis that *the magmatic ores in general have been introduced at a late magmatic stage as a result of mineralizers, and that the ore-minerals replace the silicates. This replacement, however, differs from that caused by destructive pneumatolytic or hydrothermal processes in that quartz and secondary silicates are not formed at the time the ores are deposited.*

None of the magmatic ores are entirely free from alteration, and in some cases they are associated with high-temperature alteration products as well as with those of hydrothermal origin. It became necessary for us, therefore, to study the various stages of mineral deposition, especially the migrations and alterations that follow the original deposition of the ore.

Some of the data indicating that the magmatic ores are later than the silicates have influenced a number of geologists to question the propriety of classifying certain deposits as magmatic and perhaps to doubt the importance of the type as a whole. Our work meets the objections urged by opponents of the magmatic theories in that it proves the ores are formed within the magmatic period, as defined by us, altho the ore-minerals are later than the silicates.

Classification of the Magmatic Ores

Vogt[7] separates the magmatic ores according to mineral composition into three groups, viz.: the oxid ores, the sulfid ores, and those of the native metals. The last group includes nickeliferous iron, platinum, copper, and gold. The magmatic deposits of nickeliferous iron and of platinum are curiosities rather than ore deposits. The existence of magmatic copper and gold has been asserted, but not proved by accurate microscopic work. Therefore they are not considered further by us. The oxid group includes deposits of chromite, corundum, and, most important, of magnetite and ilmenite. Altho we touch upon these briefly, the study presented here deals chiefly with the magmatic sulfid deposits. These sulfid ores have been classified as magmatic because of their exclusive occurrence in igneous rocks; because the ore formation is not accompanied by pneumatolytic, contact, or hydrothermal silicates, so markedly developed in connection with sulfid deposits of the non-magmatic types in igneous rocks; and because the

[7] Zeit. f. prakt. Geol., Jahrgang 1894, p. 382.

ore-minerals have been considered by some to be contemporaneous with, or even earlier than, the silicate minerals of the igneous rock.

The magmatic sulfid ores have been divided into three groups: (1) the pyrrhotite-chalcopyrite deposits in norite and gabbro; (2) chalcopyrite-bornite deposits in norite and diorite;[8] and (3) the so-called intrusive pyritic ores. We mention the third group but briefly, and doubt the propriety of classifying these deposits either as "intrusive" or as "magmatic."

Deposits Studied

Of the first group, the examples studied in detail by us include the ore deposits at Sudbury, Canada; those of the Alexo mine, Canada; and of minor importance, the deposits at Litchfield, Conn.; in San Diego county, California, and of the Golden Curry mine, Montana. We also summarize the important data available in the literature on the deposits of Norway, Sweden, Saxony and Bohemia, and South Africa. The deposits of the second group studied include those of Ookiep, Namaqualand, South Africa, and of the Engels mine, Plumas county, California.

Plan of Treatment

In the first portion of this article we discuss briefly the conclusions in regard to magmatic differentiation in general that we believe are justified by recent studies by Bowen and others, and summarize our conclusions regarding the magmatic ores, without referring in detail to the microscopic and field data on which they are founded.

In the second part we present our studies of the various sulfid ores examined, and summarize the critical data found in the literature in regard to each occurrence.

Part three contains a brief summary of our conclusions and a statement of the criteria by which the magmatic ores may be recognized.

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[8] The second subdivision of the magmatic sulfid ores was suggested by Stutzer [Zeit. f. prakt. Geol., 15, 311 (1907)] and the importance of the group was established by the detailed descriptions of the productive deposits in Little Namaqualand [Rogers, A. W.: The nature of the copper deposits of little Namaqualand. Proceed. Geol. Soc. of South Africa, Jan. 31, 1916], and of the Engels mine, California [Turner and Rogers (A. F.): A geologic and microscopic study of a magmatic copper sulfid deposit in Plumas county, California, and its modification by ascending secondary enrichment. Econ. Geol., 9, 359-391 (1914)].

PART I.

DISCUSSION OF THE BEARING OF MAGMATIC DIFFERENTIATION ON ORE SEGREGATION

Review of the Current Theories of Magmatic Differentiation

Magmatic deposits mark the beginning of the ore-forming processes, and they register the early stages of ore formation, often little modified by the complicated processes that follow. The science of ore deposits is largely theoretical on account of the lack of definite information regarding the relation of the ores to the associated minerals. Our microscopic study, carried on during the past two years, is an attempt to get at the facts for this class of ores—a class generally neglected by American geologists.

The conclusions we have reached in regard to the origin of the ores, and to the order of sequence of the ore-minerals, appear to us to have a broader application than to nature's processes of igneous metallurgy. Altho magmatic ore segregations are merely uncommon rock types,[9] nevertheless their study reveals certain of the magmatic processes more clearly and more in detail than do the simpler non-ore-bearing rocks. The relatively new microscopic study of ores may, perchance, make some contribution to the older science of microscopic petrography.

The present time is especially opportune for the presentation of our results because the recent work of Bowen,[10] along both theoretical and experimental lines, affords a foundation in the definite conclusions reached in regard to the important factors governing rock differentiation, and his work possibly has relegated to the scrap heap of discarded theories a number of the hypotheses as to the processes of differentiation.[11]

In view of the detailed discussion by Bowen it is only necessary to mention the two important groups of hypotheses that he now con-

[9] Crook, T.—The genetic classification of rocks and ore deposits. Mineralog. Mag., 17, 55 (1914).

[10] Bowen, N. L.—The later stages of the evolution of the igneous rocks. Jour. Geol., 23 (supplement), 1-91 (1915).

[11] For an excellent summary of the theories of differentiation see L. V. Pirsson, Bull. U. S. Geol. Surv., no. 237, 183-189 (1906).

siders untenable, in order to clear the discussion of the conclusions that are based on them. The first group includes those hypotheses favored by Vogt, Iddings, and Becker that postulate the segregation of mineral compounds in a molten magma by diffusion in a single liquid phase. The flow or diffusion of the materials first to crystallize may be towards the cooler portion of the magna reservoir (the sides) according to the Soret principle, or the segregation may be assisted by convection currents in the magma (Becker), or may be controlled by gravity ("density stratification"). The second group includes the so-called liquation hypotheses, which postulate the formation of immiscible liquid phases (Rosenbusch, Backström, and others). This group of theories has been favored by geologists because it affords a ready explanation of many of the observed field relations, such as the successive intrusion of "basic" and "acid" dikes, etc. However, no evidence of even minute globules indicating immiscible liquids has been found in lavas or in the quenching experiments[12] carried on in the Geophysical Laboratory at Washington.

Theories Favored by Us

We believe that differentiation is accompanied chiefly by sinking of crystals of an early generation to form "basic" rocks, as emphasized by Bowen, and the resultant segregation of "acid extracts" and gases in the liquid portion.[13]

We emphasize the hypothesis that differentiation involves two distinct and at the same time complementary processes: (1) Initial differentiation takes place at an early stage in the consolidation of the magma, at high temperatures, and under relatively anhydrous conditions, and results in the concentration of certain ferromagnesian minerals by the sinking of the early-formed crystals. (2) As a result of the crystallization and removal of the mafic minerals, there is a concentration in the still fluid magma of the felsic constituents, of gases and of mineralizers, of those elements (chiefly the precious and base metals) the crystallization of which is delayed by mineralizers (chlorin, fluorin, boron, water, hydrogen sulfid, etc.). This process finally develops a series of "acid extracts" which form pegmatite and aplite dikes, contact deposits (by the reaction of these extracts upon

[12] Bowen, N. L.—Loc. cit., 9-10.

[13] Smyth, C. H. Jr.—The chemical composition of the alkaline rocks and its significance as to their origin. Am. Jour. Sci., (4), 36, 33-46 (1913).

Lane, A. C.—Wet and dry differentiation of igneous rocks. Tufts College Studies (Scientific series), 3, 39-54 (1910).

calcareous rocks), high-temperature quartz veins of the pneumatolytic and allied types, and the various succeeding families of intermediate-temperature ore deposits.[14]

Owing to the vicissitudes of successive differentiation and intrusion, and possibly of remelting and reintrusion, individual masses of "basic" composition are encountered, such as peridotites, gabbros, diorites, and others of "acid" composition such as quartz monzonites, quartz diorites, granites, etc. We believe that, on cooling, each must have undergone an early ("basic") and a late ("acid") differentiation. In the subsilicic rocks one would expect the products of initial differentiation to be most important, and the final "acid extracts" to be small in amount and feeble in action; while the products of the first crystallization of persilicic magmas should not, in general, be rich in the mafic silicates and oxids, but the final extract should develop abundant pegmatite dikes and quartz veins. The latter, altho often important as ore carriers, are not considered magmatic ores in the strict sense of the term, and for this reason we confine our attention to the sulfid and oxid ores segregated in, and at the margins of, gabbro and norite intrusions.

Problems to be Investigated

Our task is to determine whether these ores, chiefly magnetite, pyrrhotite, chalcopyrite, and bornite, are the early-formed minerals of the magma, or whether they are formed at a late stage, and are accompanied and segregated by the action of an "acid extract" developed by the crystallization of a dominantly "basic" rock. The question is of importance in the general theory of ore deposits. Is ore formation connected with the gaseous extracts developed during the late stages of the consolidation of igneous rocks? Or are there, on the other hand, two unrelated processes of ore formation, one confined to the early stage of the consolidation of the magma, and only of importance in femic rocks, and the other to a later stage, and developed chiefly in connection with salic rocks? If so, the two types of ore will be concentrated at different places, one at the base of the intrusive magma and the other near its upper and outer margins. Their accumulation will be effected by different factors. The correct answer to the question may throw light on the obscure problems of the crystallization of deep-seated magmas. Do all the minerals of igneous rocks crystallize in a regular order according to the laws

[14] Tolman, C. F.—The magmatic origin of ore-forming solutions. Min. and Sci. Press, **104**, 401-404 (1912).

of solubility in anhydrous melts, or are the relations more complicated? Do the gaseous extracts react on the earlier minerals to form new minerals; and is there in the later stages actual replacement of one substance by another? Are these stages followed by others that are typically hydrothermal? Can these various stages be recognized and distinguished from each other?

METHODS OF INVESTIGATION

These problems may be attacked by three different methods of research, viz.: (1) experimental investigations; (2) field investigations; (3) microscopic investigations.

Experimental Investigations.—Simple rocks consisting of not more than four components can be made and investigated in the laboratory. As yet these have been studied only under anhydrous conditions and without the addition of volatile mineralizers. The work of the staff of the Geophysical Laboratory at Washington has added to the accuracy of our knowledge of crystallization under these conditions. However, both Day [15] and Bowen [16] recognize the importance of the action of mineralizers, but as yet the difficult problem of studying crystallization under the control of volatile mineralizers has not been undertaken. Bowen [17] states: "It will probably be a long time before important aid in attacking the questions can be expected from the experimental side, on account of the difficulty of treating systems containing volatile compounds." Until these are investigated we have not advanced far in the solution, along experimental lines, of the fundamental problems of rock and ore genesis. Up to date experiment has taught us that the common minerals such as olivine, the pyroxenes, and the lime-soda feldspars can segregate by sinking of these crystals in a melt. Analogy suggests, perhaps, that the accessory minerals, especially magnetite and sulfids. which are commonly thought to be among the earliest of the minerals to crystallize out of a magma, might segregate in a similar manner. However, magnetite, apatite, ilmenite, and the sulfids are carried on by mineralizers into the stages of the formation of pegmatites and quartz veins, and therefore are formed at a late stage of rock consolidation. The problem, then, as to whether the magmatic ore deposits of the iron oxids and the metallic sulfids are consolidated during the initial or late magmatic stages has not yet been attacked by experimental work. The experimental researches of Vogt [18] on molten sulfids, valu-

[15] Day, A. L.—Some mineral relations from the laboratory viewpoint. Bull. Geol. Soc. Amer., 21, 141-178 (1910). [16] Loc. cit. [17] Loc. cit.

[18] Vogt, J. H. L.—Die Silikatschmelzlösungen, (1903-04).

able as they are, have little or no application to the problem, as he experimented with dry melts, and no attempt was made to experiment with an enclosed system into which mineralizers were introduced.

Field Investigations.—The second line of attack is the study and analysis of field relations. Are the magmatic ores always located at the base of a differentiated igneous rock? If this occurs in some cases, is the location at the base of the intrusive rock due to other processes than the sinking of the first-formed crystals? On the other hand, do the ores show any suggestive relation to the salic differentiate (pegmatite dikes, etc.) of the dominantly femic magma? Are the magmatic ores related to fractures developed after partial consolidation, and may these fractures concentrate and release the "acid extracts," and thus localize the ores? Do the ores migrate into, and replace, the country rock? Are the magmatic ores followed in some cases by ore deposits of hydrothermal origin, into which they may grade?

Apparently field evidence alone is not conclusive, or at least has been variously interpreted, for and against, the magmatic origin of the ores. At Sudbury, the location of the ores at the base of the norite sill has been considered strong evidence of magmatic origin during the early stages of consolidation. On the other hand, Knight [19] has recently presented field evidence which he believes is proof of the hydrothermal origin of the ores. The field evidence regarding the deposits investigated appears to us to be of a corroborative rather than of a conclusive nature.

MICROSCOPIC INVESTIGATION

The determination of the age of the ore-minerals in magmatic deposits is merely one phase of the general problem of the determination of the order of crystallization of minerals in igneous rocks. The problem is complex and difficult as far as the early silicates are concerned, as is witnessed by the differences of opinion expressed in recent contributions,[20] and by the doubt[21] thrown on Rosenbusch's fundamental law of decreasing basicity.

These difficulties disappear, however, in regard to the late magmatic minerals, for by microscopic examination of both polished and

[19] Knight, C. W.—Origin of Sudbury nickel-copper deposits. Eng. and Min. Jour., 101, 811-812 (1916).

[20] Bowen, N. L.—The order of crystallization in igneous rocks. Jour. Geol., 20, 455-468 (1912).

Ziegler, V.—The order of crystallization in igneous rocks. Jour. Geol., 21, 181-185 (1913).

[21] See Vogt, Die Silikatschmelzlösungen, 1, 160.

thin sections (see page 74 for methods employed) we have found evidence that the ore-minerals surround, cut, and replace the earlier silicates.

The more important microscopic investigations of certain of these types of ores include those of Beck, Vogt, Dickson, Campbell and Knight, Howe, and Berg, to which reference is made in the appropriate places. Many of the conclusions of these investigators are verified by us.

Conclusions from our Microscopic Investigations

Some of the important facts that appear to us to be established by microscopic study for both the sulfid and iron oxid ores of magmatic origin are as follows:

The ore-minerals are the final magmatic product, and are formed later than the magmatic hornblende, which we believe to be produced by magmatic alteration.

The ores replace the silicates and, in general, the later-formed ore-minerals replace the earlier ore-minerals.

There is a regular order of formation of the magmatic minerals, which shows no variation in the deposits studied. For the nickel-copper group of sulfid ores it is as follows: (1) silicates, (2) magnetite and ilmenite, (3) pyrrhotite, (4) pentlandite, and (5) chalcopyrite. For the chalcopyrite-bornite group the order is: (1) silicates, (2) magnetite and ilmenite, (3) hematite, (4) pyrrhotite (when present), (5) chalcopyrite and bornite. All alteration minerals, except hornblende, are later than the above mentioned magmatic ores. In some cases minor amounts of "rearranged ores" have been recognized, but the extent of the rearrangement is surprisingly small.

From the field relations we find that the ores may be followed by pegmatite dikes (often containing ore-minerals) and by later series of hydrothermal ore-bearing veins.

The Evidence on which the above Conclusions are based

We conclude that the ores are later than the silicates, for the reason that all the silicates indiscriminately occur as relicts in a ground mass of ore. The ore-minerals surround the silicates, enter along the contacts between them, cut them, and penetrate easily cleavable minerals such as biotite. In some cases they cut the silicates in well defined veinlets. These relations are explained, in part, by those favoring an early magmatic origin of the ores as follows: The sulfid ores remain in a molten condition during the formation of the primary

silicates (we add: during the formation of the late magmatic hornblende), and then solidify.

The presence of hornblende, however, suggests a moderate temperature (far below the melting point of the sulfids) and the presence of water [22] and other mineralizers. Further, it is certain that the ore-minerals have either replaced or corroded the silicates. This is proved by "intersecting structures" [23] and by the fact that portions of crystals have been removed and their place taken by ore-minerals. Berg,[24] describing the magmatic nickel-bearing sulfid ores, states: "Sie (the nickel-bearing sulfids) umschliessen nicht nur gelegentlich alle anderen Gemengteile, sie resorbieren dieselbe nicht nur zu rundlichen Massen, sondern sie korrodieren sie auch öfters, indem sie ganz nach den Gesetzen der metasomatischen Verdrängung längs Spaltrissen und mechanischen Spalten in diese eindringen."

The preservation of the form of antecedent crystals, especially magnetite and olivine, is accomplished by selective replacement. Graphic texture is preserved by the replacement of feldspar of the quartz-feldspar intergrowth. Often the various stages in the replacement of a mineral, from incipient to complete, may be noted.

Replacement Phenomena in the Magmatic Ores

The process, however, is not one of corrosion, but of replacement. If the ores were molten, corrosion should produce metallic silicates by reaction. No such metal-bearing slag is found. The phenomena are those of ordinary replacement, and the agency that brought in the sulfids removed the dissolved silicates, all of which indicates active mineralizers.[25]

The regular order in which the sulfid minerals are deposited one after the other, and the fact that one replaces the other, indicates deposition by mineralizing solutions, and not the intrusion of molten sulfids.

[22] Harker, A.—The natural history of igneous rocks, 289 (1909).

Bowen, N. L.—Loc. cit., 41.

[23] Irving, J. D.—Replacement ore bodies and the criteria for their recognition. Econ. Geol., 6, 647 (1911).

[24] Berg. G.—Mikroskopische Untersuchung der Erzlagerstätten, 107-108 (1915).

[25] We regard sulfur as a mineralizer of importance in the magmatic stages in this type of deposits. Sulfur is not usually considered a mineralizer by petrographers, but it is recognized to be such by de Launay and the French school generally, beginning with de Beaumont. [Bull. Soc. Geol. France, 4, pt. 2, 1268 (1847).] The recognition of sulfur as a mineralizer calls attention to the arbitrary distinction between the terms "mineralizer" and "mineralization."

This last point may be met, in part, by Howe's hypothesis that the molten ores are mixtures of mutually immiscible sulfids, and that those last to crystallize penetrate the earlier sulfids. This suggestion does not overcome the difficulties raised by the replacement of the silicates by ores, and antecedent ore-minerals by later ores, without the formation of reaction rims. The absence of the latter shows that the replaced material is removed by the same vehicle that brought in the ore.

The accumulating evidence of the low temperatures [26] at which the final stages of the consolidation of an intrusive magma take place, discredits the notion that a sulfid melt, similar in character to that with which we are familiar in the reverberatory furnace, can exist after the final consolidation of the silicates of the magma. Its "molten" condition must be due to mineralizers, in such amounts that the characteristics of the mixture are those of a high-temperature solution and not of a melt.[27]

We can find no support whatever for the idea that the sulfids separated as molten mixtures and solidified later.

In our microscopic studies of contact-metamorphic deposits we have found definite evidence that the ore-minerals are later than the high-temperature silicates such as garnet, pyroxene, etc. Similar data lead us to believe the same is true for all the high-temperature deposits.

We have come to the conclusion, therefore, that the formation of sulfids takes place at a late stage in all types of high-temperature deposits, probably not higher than 300°-400° C. In this estimate we differ greatly from Lindgren,[28] especially for the magmatic deposits, who believes that the ores are about contemporaneous with the high-temperature silicates.

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[26] Harker, A.—Loc. cit., 184-188.

[27] Beck calls attention to the physical improbability of molten sulfids entering into the cooler country rock adjacent to the intrusives, and states that the "corrosion" of the silicates has been caused by water solutions, and believes that in many cases the ores have formed after the regional metamorphism of the gabbros, and are younger than the hornblende and garnet. [Lehre von den Erzlagerstätten, dritte Auflage, erster Band, 72-73 (1909).]

[28] Lindgren (Mineral Deposits, 188) gives the ranges of temperature for the high-temperature deposits as follows:

Magmatic deposits, 700° to 1500° C.

Contact deposits and allied veins; pegmatites, 300°± to 800°±.

Vein and replacement deposits formed at great depths, 300°± to 500°±.

Alteration and Later Rearrangement in Magmatic Ores

The sharp sulfid veinlets will be recognized by all as later than the silicates they cut. They furnish no stronger proof, however, of the late origin of the ores than the larger scale relations, such as the surrounding and penetration of the silicates by the ore-minerals. The well-defined veinlets in the magmatic ores have been explained as "later rearrangements." Lindgren[29] states, in discussing Uglow's description of the replacement and vein phenomena shown in the nickel-bearing sulfids at the Alexo mine, Ontario: "Here, as in so many other cases, secondary changes appear to have been confused with primary deposition." Coleman, writing of the Sudbury ores, states:[30] "That there has been a certain amount of solution and redeposition in many of the ore deposits is admitted by all, but this was of the nature of a rearrangement of the minerals of the rock."

We devoted considerable time to the investigation of the veinlets, vein-like replacements, and alteration products accompanying the ores, in order to determine the extent of these later rearrangements. Numerous sulfid veinlets occur in certain of the Sudbury ores, but the examination of these shows no indication of more than one generation of ore-minerals. These veinlets lead out from large sulfid masses and show no rearrangement, nor are they accompanied by contemporaneous alteration products, as is the insignificant second generation of ore-minerals occasionally met with. Where the sulfid veinlets cut a zone of reticulated fractures filled with alteration minerals, the sulfids do not penetrate these fractures, and therefore they were deposited before the alteration. No greater amount of alteration is found in the ores with, or in the neighborhood of, the veinlets than elsewhere. The sulfid veinlets are found in the normal norite, in the "acid material," and in the "basic" segregations, so that the ore is younger than all these three types of rocks.

None of the magmatic ores are entirely free from the products of secondary alteration, but all the secondary minerals except the late magmatic hornblende are definitely later than the ore-minerals. In a single slide a portion of the ore may be unaccompanied by alteration products, and another portion may be surrounded and cut by later secondary silicates; but the relations of ore to gangue are the same in the altered portions as in the fresh, and there is often no indication

[29] Lindgren, W.—Mineral Deposits, 765.

[30] Coleman, A. P.—The nickel industry, Canada Dept. Mines, Report 170, p. 31 (1913).

of secondary migration of ore-minerals, even where they are cut by veinlets of chlorite. The striking thing about the magmatic ores in general is the slight amount of rearrangement they have undergone.

The results of our study of the ores of the Alexo mine, Canada, are of interest in showing that, altho the silicates are intensely altered, and completely serpentinized, nevertheless the ore is only slightly affected. Here the serpentinization is subsequent to ore formation, as shown by veinlets of serpentine cutting the main ore masses. Two generations of serpentinization are recognized; the first accomplished the segregation of insignificant veinlets and specks of chalcopyrite within the area serpentinized, but apparently did not modify even the outline of main masses of ore; the second generation of serpentine is accompanied by still more minute scattered microscopic specks of ore. Only a small portion of the total ore suffered rearrangement during the process of serpentinization.

Absence of Pneumatolytic and Hydrothermal Alteration During Ore Deposition

One of the characteristics of magmatic ores that has long been emphasized in the literature is the lack of secondary silicates produced by pneumatolytic and hydrothermal processes. In a few cases, however, the ores are accompanied by high-temperature minerals, such as garnet and tourmaline, and show gradations, therefore, towards the groups of high-temperature epigenetic ore deposits. Our work shows that hydrothermal alteration is invariably later than the period of magmatic ore formation, and therefore emphasizes the lack of alteration during the formation of the ores. It has been argued that if mineralizers or solutions are involved in the formation of the magmatic ores, they must of necessity not only dissolve the rock and deposit the ore, but must also react with the rock-forming minerals to produce secondary silicates. For example, Vogt [31] was at first inclined, from field and microscopic data, to attribute the origin of the nickeliferous sulfids of Norway to "pneumatolytic" action; but the lack of the products of destructive pneumatolysis evidently caused him to abandon the idea that mineralizers are the agents of ore concentration, and he adopted the concept of an intrusive sulfid magma.

The idea that alteration invariably accompanies ore deposition is probably due to a considerable extent to the emphasis given rock alter-

[31] [Geol. Fören. Förh, 1883] cited by Beyschlag, Krusch, Vogt, Erzlagerstätten, p. 285.

ation in the classic paper of Lindgren.[32] As a matter of fact, a careful microscopic examination by us of many types of non-magmatic ores has discovered veinlets or portions of veinlets along which the rock is little altered; and where the rock is affected, this alteration may be earlier or later than the deposition of the sulfids, and not connected directly with it. In replacement deposits in limestone, the most easily altered of all rocks, the ore often lies in contact with the limestone without intervening secondary minerals. *A priori,* no reason can be found why the composition and temperature of the ore-forming solutions in general should not be such that solution of the rock-minerals and deposition of the ore-minerals may take place without the formation of secondary silicates. *A fortiori,* this would be expected in the case of the ores under discussion. In the late stages of the consolidation of igneous rocks, constructive action of mineralizers aids and controls the formation of minerals without the development of secondary silicates. We have much to learn from the French scientists of the importance of mineralizers[33] in the crystallization of igneous rocks.

Extensive destructive pneumatolysis often occurs in connection with certain stages in the formation of pegmatite dikes and high-temperature veins, and results in the development of such minerals as quartz, muscovite, tourmaline, topaz, scapolite, etc. The temperature and character of the solutions and mineralizers are such that they are not in equilibrium with the minerals attacked, and they contain chemically active gases, such as boron, chlorin, fluorin, etc. They therefore develop in the country rock the complicated set of silicates mentioned.

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[32] Lindgren, W.—Metasomatic processes in fissure-veins. Trans. Am. Inst. Min. Eng., **30**, 578-692 (1900).

[33] There is a striking difference between the German and American schools of petrography and the views of the French scientists. The former have interpreted the conditions governing the crystallization of deep-seated magmas in the light of observations on surface lavas and experiments on anhydrous melts. The latter have been impressed with the fumarolic action around volcanic vents, and have therefore concluded that mineralizers are important components in intrusive magmas. [Lacroix, A.—Les mineraux des fumerolles de l'eruption du Vesuve en avril 1906. Bull. Fr. Soc. Min., **30**, 219-266 (1907).] Extreme views in regard to the role of mineralizers have been expressed by de Launay [Traité de Metallogenie. Gites minéraux et metallifères, **1**, chap. I (1913)] who has developed a theoretical concept of the constitution of the earth involving a central metallic core with a superficial slag or silicate crust. He believes that mineralizers react upon the "slag," producing granite and other rocks, and form various types of ore bodies from the metals they have "extracted" from the metallic core.

We conclude that the magmatic ores, in contrast with the pegmatites and "high-temperature veins," occur in rocks which are little affected by the destructive action accompanying the latter.

The lack of alteration during the formation of the magmatic ores in "basic" rocks is probably the result of chemical composition rather than of temperature. The mineralizers of the "basic" rocks containing the magmatic sulfids produce hornblendization and biotitization, while those of "acid" rocks produce marked destructive effects (greisenization, tourmalinization, silicification, contact action, etc.).

The lack of alteration during ore formation, the fact that ore formation is often followed by the intrusion of pegmatitic differentiates, also the fact that the ores are limited to the parent "basic" rock and migrate into the intruded rock only to a very minor degree, are the chief characteristics of this definite and recognizable type of ore which has been designated as magmatic. Therefore we may well retain this term, even tho certain misconceptions have been attached to it, such as consolidation in the early molten stage, injection of molten sulfids, etc.; recognizing that the microscopic examination definitely proves only that the ores are later than the primary silicates and earlier than the hydrothermal silicates, and also that the period of metallization is further removed from the main stages of rock consolidation than is generally believed.[33a]

Magnetite-Ilmenite Magmatic Ores

We have studied, chiefly, the magmatic sulfid ores, and for these there is no doubt that the ores are later than the silicates. The same is true for the magnetite-ilmenite ores we have examined; and a review of the literature of these deposits containing accurate microscopic descriptions shows this to be true for all the iron ores of this type, altho the bearing of this fact on the theories of magmatic differentiation does not appear to have been duly emphasized or appreciated.

Euhedral Magnetite Formed at a Late Magmatic Stage

Berg[34] recognizes in the majority of magmatic iron-oxid deposits two generations of magnetite: euhedral magnetite earlier than the sili-

[33a] At various times during the progress of our studies, we have considered the advisability of discarding the term "magmatic ore" in favor of some such name as epimagmatic. The fact that we have not been able to discover ores that show evidence of having been formed during the early stages in the consolidation of the magma, that the activity of mineralizers increases as crystallization progresses, and that any division between earlier and later minerals would be arbitrary, has deterred us from suggesting any departure from the present nomenclature, altho such

cates, and larger areas of magnetite later than, and "corroding," the silicates. As magnetite is also a constituent of the magmatic sulfid ores, and as it occurs both as euhedral crystals and anhedral masses replacing the silicates, we were able to investigate the question as to the occurrence of the two generations of magnetite. We find that there are all gradations between small euhedral crystals and the large irregular areas of magnetite. The points of the larger masses may show crystal faces where they penetrate well into the silicate minerals. The magnetite appears to develop irregular forms where it surrounds the silicates, apparently following the lines of least resistance along the mineral boundaries, but develops euhedral forms within the silicates, where no line of weakness disturbs its tendency to crystallize regularly. We believe that the magnetite in the magmatic sulfid ores, and probably in the magmatic ores in general, is all deposited later than the silicates.

Other Accessory Minerals of Probable Late Magmatic Origin

The accessory minerals of igneous rocks, such as magnetite, ilmenite, apatite, titanite, zircon, etc., are considered by petrographers to be the first to crystallize in igneous rocks, on account of their euhedral form, and their occurrence within the silicates that make up the mass of the rock. As the effect of mineralizers is not generally recognized in developing new minerals in the igneous rocks the possibility has not been considered that these minerals form in the later magmatic stages by replacement.[35] Euhedral crystals of pyrite in igneous and sedimentary rocks and of garnet and magnetite in metamorphic rocks, are found unaccompanied by any adjacent alteration zone. In a similar manner we believe that euhedral magnetite, and probably other accessory minerals, are the product of mineralizers developed during the late magmatic stage.

The high-temperature minerals forming the bulk of the igneous rocks are formed at an early stage. The accessory minerals present in small amounts are not formed until a late stage and then under the influence of mineralizers. The difficulty is thus avoided as to how the magma, at an early stage, could become saturated in relatively insoluble compounds present in small amounts, and how these again could make their appearance in large amounts among the last products of consolidation.

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a change might assist in clearing up misconceptions in regard to the magmatic ores and the processes of magmatic differentiation. [34] Loc. cit., 102, 105.

[35] "If crystals of one primary mineral completely enclose crystals of another, the evidence of their relative age is absolute." (Harker, loc. cit., 179.)

Stages Recognized in the Formation of Magmatic Ores

From the above discussion it is clear that we conceive of the process of formation of plutonic rocks as consisting of stages, and that rock differentiation and ore formation are the results of an orderly series of events.

The process varies in detail with the composition and size of the individual intrusive masses undergoing crystallization. The stages in the norites and gabbros which contain the magmatic sulfid ores are as follows:

(1). The first minerals to form are olivine, the pyroxenes, and the feldspars.

(2). Magmatic alteration of the silicates often takes place prior to the formation of the ore-minerals. The most common change is that of pyroxene to hornblende (not uralite). The not uncommon hornblende gabbro, for example, may be developed by this late magmatic process, for the hornblende has probably been formed at the expense of pyroxene.

(3). Later magmatic products include interstitial pegmatitic material, interstitial quartz, and occasionally tourmaline, garnet, analcite, epidote, and calcite.

(4). The introduction of the ores by mineralizers is later, in general, than the minerals of group (3) and is unaccompanied by any secondary silicates.

(5). The pegmatite dikes, found in the neighborhood of almost all of the magmatic sulfid ores, are often later than the magmatic deposits of the basic rock itself.

(6). Hydrothermal alteration subsequent to magmatic ore deposition includes the development of chlorite, tremolite, anthophyllite, sericite, and serpentine. In general, hydrothermal alteration, altho seldom lacking, is insignificant compared with that developed in connection with deposits of other types in igneous rocks, such as those of Butte, Bingham, etc. It often does not accomplish any rearrangement of the ore, altho, in some cases, insignificant amounts of pentlandite, chalcopyrite, chalcocite and covellite are formed.

(7). At a later stage, downward enrichment and oxidation may take place. Magmatic deposits, in all cases examined, owe their metallic content to the original magmatic minerals and not to later introduced sulfids.

PART II.

DESCRIPTION OF THE VARIOUS DEPOSITS OF THE MAGMATIC ORES

GROUP I. THE NICKEL- AND COPPER-BEARING PYRRHOTITIC DEPOSITS

SUDBURY, CANADA

Geology

Those who favor the hypothesis that the Sudbury ores separated out of the magma as an early, or the earliest, constituent, and sank and collected by gravitative differentiation,[36] cite field relations as proving their contention. In spite of the voluminous literature in which these relations have been described, there are still many points in regard to which no agreement has been reached. A discussion of the genesis of these deposits is therefore incomplete without a summary of the established field relations and a statement of the problems that are unsolved as yet. Fortunately Coleman [37] has mapped in detail both the upper and lower margins of the laccolithic sheet, and given much information in regard to the structure of the individual deposits. The accompanying map (fig. 1) is drawn from a photographic reduction of his large-scale map.

As is well known, the pyrrhotite-pentlandite-chalcopyrite ore bodies of the Sudbury district occur at the base of a great sheet of "norite-micropegmatite." As shown on the map, the sheet is of unusual regularity for an intrusive mass of its size and character. It is overlain by 9000 feet of Upper Huronian sandstones, shales, conglomerates, and tuffs, which make a gentle syncline concordant in dip with the norite sheet, and underlain by a sedimentary series of great thickness (30,000 feet according to Coleman), predominantly of quartzite with included older basic irruptives. These older strata, "the Sudbury series" of early Huronian or pre-Huronian age, dip regularly to the southeast, averaging

[36] Coleman, A. P.—The nickel industry. Can. Dept. of Mines, Mines Branch. Publ. 170 (1913).

Barlow, A. E.—Geol. Surv. Can., **14**, pt. H, 1-124 (1904).

[37] Loc. cit.

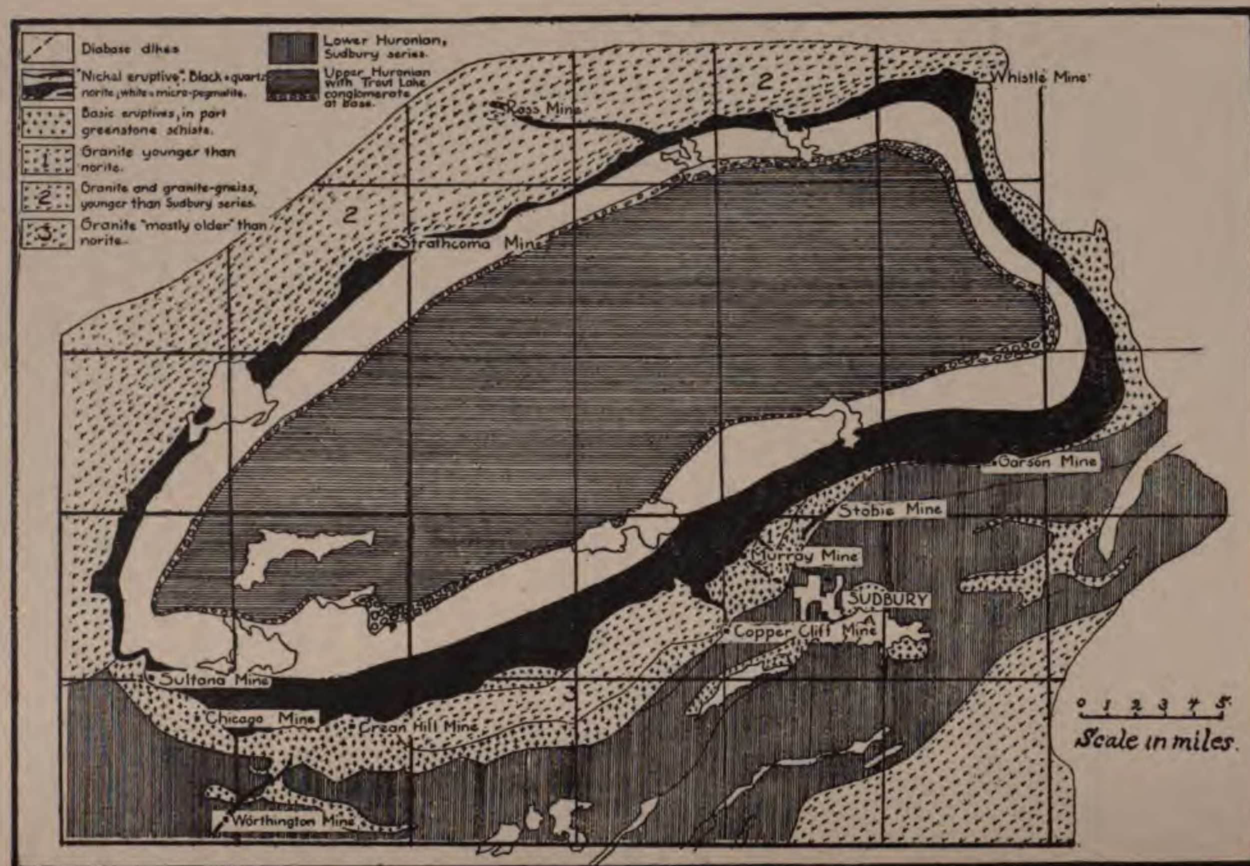

Fig. 1. Geologic Map of the Sudbury District. Drawn from a photographic reproduction of Coleman's latest map accompanying The Nickel Industry, Publ. No. 170, Canada Dept. of Mines.

45°. The "nickel eruptive," as the norite sheet has been named by Coleman,[38] therefore, has taken advantage of the unconformity between the older and younger sedimentary series, and has lifted the latter on its back without disturbing it otherwise than to develop a gentle spoon-shaped syncline.

No accurate sections across the syncline have been made, but judging from the areal map and the descriptions and sketches of the ore bodies located at the contact between the nickel eruptive and the underlying formations, the dip of the eruptive sheet at its basal contact is 40° to 45° at the surface, generally decreasing to 30° to 35° at a depth of about 1000 feet.

Coleman[39] has pictured in the following vivid language his concept of the manner in which the great laccolith forced its way into the sedimentary rocks:

"After the succession of sediments just mentioned had been deposited, the vast mass of molten rock of the nickel eruptive ascended, mostly from beneath an area near the middle of the southern range, as will be shown later. As the molten magma welled up from below, the crystalline rocks forming the roof of the great crucible gradually collapsed as a block twelve to fifteen miles long and several miles broad, giving rise to extensive faulting and fissuring. . . . "

"The eruptive sheet cooled extremely slowly, partly because of the great bulk of molten material and partly because of the thick mantle of sedimentary rocks above; and during the cooling much of the ore sank to the bottom, though its upper part remained mixed with norite, which finally blended into micropegmatite or granite on top, the three materials arranging themselves according to their specific gravities. . . . "

"The norite-micropegmatite sheet is one of the largest laccolithic sheets known, containing not less than 600 cubic miles at the present time, and probably having had a much greater bulk in the beginning."

Subsequent to the intrusion of the nickel eruptive, both granite masses and dikes and basic dikes were intruded along the under contact of the sill, and both "acid" and "basic" dikes cut the ore bodies.

One of the most important problems, as yet unsolved, is the origin of the "acid material," largely quartz and feldspar, frequently developing marked micropegmatitic structure, that occurs enclosed in many of the

[38] Coleman, A. P.—The Sudbury laccolithic sheet. Jour. Geol., **15**, 752-782 (1907).

[39] Canadian Dept. Mines, Pub. 170, p. 10 (1913).

ore bodies. Equally important is the determination of the relation of the "later granite" to the norite. Coleman has arranged the granitic rocks in three groups (see geological map, page 24). (1) Granite and granite-gneiss younger than (intrusive into) the Sudbury series and older than the norite; (2) granite mostly older than norite which was mapped without discrimination between "the older" and "the younger" groups which are of widely different origin; (3) granite younger than norite, a small area of which is shown near the Murray mine. The lack of detailed field and microscopic study prevents, for the present, the final answer to the questions raised above. Fortunately, however, Knight[40] has been studying these questions in the course of his detailed field work, and we look forward to the publication of his conclusions with great interest.

In regard to the micrographic segregations and inclusions of granitic material in the ore, we believe with Coleman[41] that they are differentiates of the norite.

The micrographic structure is typical of the upper portion of the "nickel intrusive." Its occurrence in the ores as blebs and interstitial material, as well as large masses, and the variations shown in a single thin section, suggest that both the norite and the "acid" material are differentiates of a common magma.

In this regard Howe[42] states:

"The attractive possibility has been considered that the silicious material associated with the sulphides might represent a residual portion of the magma from which the sulphides are supposed to have been derived. . . . The microscope, however, shows over and over again the absolute similarity of the acid inclusions to the foot-wall granite."

However, the foot-wall granite to which he refers may well be the "later granite." Specimens sent us by Dr. Knight from the Creighton mine, the locality which Howe studied, are decidedly micrographic. Until further data are available, the reasonable hypothesis is that the "acid" blebs, segregates and inclusions in the Sudbury ore bodies, as well as the marginal masses of the later granite, are differentiates of the parent norite magma. In many other localities, granitic differentiates are found inclosed in, or at the margins of, the norite intrusives (see the map of the Ringerike district, Norway, page 49). At Sudbury, where all the phenomena have taken place on a large scale,

[40] Loc. cit. This article contains a preliminary statement of certain of the field relations. [41] Econ. Geol., 10, 391-392 (1915). [42] Loc. cit., 520-521.

we should expect the "acid" differentiates to appear in large amounts. The fact brought out by Knight that dikes of the later granite cut the norite, and also that the ore rests upon a footwall of younger granite, does not prove that the ores are not magmatic. The norite and granite differentiates may be nearly contemporaneous, and the "late magmatic" ores are, in some localities, earlier than, and in other places later than, the "acid" differentiates. Evidence of extensive differentiation is found generally in rocks associated with magmatic ores.

Knight, [42a] has also emphasized that the Sudbury ores have wandered out into, and replaced, the schists found at the contact with the norite.

We are indebted to Dr. C. W. Knight for specimens of several types of sulfid bearing "greenstone schists." These laminated rocks consist largely of biotite, hornblende, actinolite, chlorite, clinozoisite, quartz, and plagioclase. One of these, a chlorite-actinolite gneiss from the Garson mine, is shown in fig. 10. The ore-minerals, pyrrhotite and chalcopyrite, occur in linear areas parallel to the plane of schistosity. Under the microscope the relations of the ore-minerals to the silcates are practically the same as in the igneous rocks examined. The sulfids surround the silicates, and evidently replace them to some extent, and minute sulfid veinlets definitely cut the silicates. Alteration products are practically absent.

This shows that the magmatic ores migrate to some extent into the country rocks, and apparently show the same replacement phenomena as are exhibited by the ores in the igneous rocks.

Structure of the Ore Bodies

Coleman, in his recent description of the Sudbury region, recognizes the following types of ore bodies:

1. *Marginal Deposits.*—These are sulfid segregations collected at the base of the main norite sheet. They gradually fade out above into barren country rock, and often show brecciation, fissuring, and "later reconcentration of ores", especially along the foot-wall, which is always a pronounced fissure. *Faulted marginal deposits* have suffered brecciation and faulting in their upper portions, and the ore has "wandered into the fissures between the blocks, either at the time as molten sulphides, or later through water transport. As chalcopyrite is everywhere the more transferable of the sulphides, it has entered the fissures more largely than the pyrrhotite. Unusually large amounts of quartz, carbonates, and

[42a] Loc. cit.

sulphides of zinc or lead are found in these two mines (Crean Hill and Garson mines) as a result of circulating waters, and these later processes have played a larger part than in most other ore bodies of the region, whether marginal or offset."[43]

2. *Columnar Offset Deposits.*—These remarkable ore deposits, the most notable of which occur in the Copper Cliff mine, are great cylindrical ore shoots.

"In the last report on the nickel region the Copper Cliff deposit was known to go down for 1,000 feet without interruption, as a rude oval pipe with diameters varying from 50 to 200 feet, and a dip of 77½° to the northeast.

"Since that time the two ore bodies of the Victoria mine, though smaller in diameter, have been followed to the depth of 1,400 feet with no indication that they may not continue indefinitely. These two small cylinders of ore, more than 1,400 feet in length and close together, but never meeting, are not at all easy to account for on any other theory than the magmatic one, and this continuance to so great a depth was not anticipated in earlier studies of the region. . . .

"There is usually more evidence of water action than in the marginal mines, and often a certain amount of quartz and of rusty weathering carbonates is mixed with the ore, probably as later effects of magmatic waters."[44]

The following ingenious explanation of these columnar ore shoots as dikes or apophyses running out from the main laccolith is favored by Coleman: ". . . it is possible that the most fluid part of the magma, the pyrrhotite-norite, entering all the fissures produced by the collapse of the underlying rock, rose from beneath under hydraulic pressure and was able, in a sense, to drill holes up through the crushed zones of rock above."[45]

3. *Parallel Offsets.*—These include the great Frood-Stobie ore deposit described by Coleman as follows:

"The Frood-Stobie offset runs nearly parallel to the basic edge, but at a distance of from ¾ of a mile to 1½ miles to the southeast. The ore more nearly resembles that of a marginal deposit than that of the ordinary offsets; and the ore body dips at an angle of 60° toward the basic edge. It is a long irregular sheet enclosing much rock, and its connexion with the edge of the norite is probably at a considerable depth below the surface. The margin of the norite parallel to it shows comparatively little ore, the sulphides belonging to it having been drained

[43] Loc. cit., 35. [44] Coleman.—Loc. cit., 36-37. [45] Loc. cit., 37.

off through a complex set of fissures to the Frood-Stobie deposit. The ore is known by diamond drilling to extend northwest beneath the country rocks to a depth of more than 1,000 feet, and at the lower points it distinctly flattens toward the basic edge of the norite. No other deposit of this type has so far been discovered; but the Frood-Stobie belt of ore is so important and so very distinct from the other types that it deserves a place by itself."

From the above descriptions it appears that the parallel offsets are mineralized dikes or sills parallel to the main foot-wall contact and dipping toward it.

From the quotations given above, it will be seen that there are evidences of hydrothermal deposition of ore and gangue minerals distinctly later than the main ore mass of the various types cited. Pyrite, marcasite, galena, sphalerite, and molybdenite are found in later veinlets, often cutting the main ore-bodies and accompanied by quartz and calcite.

Microscopic Descriptions

We are greatly indebted to Messrs. F. L. Hess, J. F. Kemp, C. W. Knight, R. D. Longyear, F. H. Mason, M. E. Morgan, H. Ries, and T. L. Walker for specimens of rocks and ores from various mines of the Sudbury district. Our study has been facilitated by the excellent suite of Sudbury rocks obtained from the Royal Ontario Museum of Mineralogy. Our specimens are believed to be typical of the Sudbury ores, as we repeatedly find the structures and relations described by other workers.

There are three fairly distinct rock types directly associated with the ores studied by us: (1) quartz norite almost free from sulfids; (2) pyrrhotite norite with fair amounts of the sulfids and with uralitized pyroxene and some hornblende; and (3) a hornblende-bearing granitic rock with abundant sulfids constituting "the rich ore." These three types represent in a general way the three kinds of material found at the mines: (1) the "lean ore" or the barren norite, (2) the pyrrhotite norite transitional to the ore, and (3) the massive ore.

Lean Ore from the Stobie Mine.—One of the lean ores studied in detail by us is a rather fine-grained quartz norite, consisting of hypersthene, plagioclase, quartz, subordinate biotite and hornblende, magnetite, pyrrhotite, chalcopyrite, and smaller amounts of secondary chlorite and tremolite. The general relations are shown in fig. 11 (plate II).

The magnetite occurs in euhedral, subhedral, and anhedral crystals. Most petrographers would assign the magnetite to the first period of crystallization, but there is clear evidence that the anhedral magnetite

was formed later than the silicates. This is shown clearly in fig. 12. The magnetite has completely surrounded one hypersthene crystal and partly surrounded two others. All of the magnetite belongs to one generation, for there is a perfect gradation from the euhedral to anhedral forms. Thus we have evidence that the euhedral magnetite was formed during the late magmatic stage. The sulfids, pyrrhotite and chalcopyrite, which are found in occasional spots, are also later than the silicates, for with the magnetite they form hook-shaped anhedra surrounding the silicates, as shown in fig. 12. The ore-minerals occur between the silicate anhedra, and while they often surround the silicates they rarely cut across an individual crystal. Careful search, however, usually reveals a few occurrences of this sort.

Alteration products occur in the sections figured, and the natural inference would be that the sulfids are connected in some way with the alteration. Alteration of the hypersthene to tremolite and the formation of chlorite have taken place, but these minerals have been formed after the introduction of the sulfids, as figs. 13 and 14 prove. In fig. 13 a chlorite veinlet cuts pyrrhotite and chalcopyrite, and in the polished section of fig. 15 similar relations are shown. A veinlet of sulfids to the left of the chlorite veinlet of fig. 13 is accompanied by tremolite, but, as shown in figs. 27, 28, 29 and 30 (plate VI), the sulfid veinlets have no connection with alteration products. The hypersthene in the lower part of fig. 12 is partially altered, but it shows exactly the same relation to the ore-minerals as does the unaltered hypersthene in the upper part of the figure. Fig. 14 furnishes evidence that the tremolite is later than the ore-minerals. The sharp needle-crystals are not residual, but project out from the altered hypersthene into the chalcopyrite mass.

The quartz norite lean ore from the Stobie mine affords clear evidence that the ore-minerals were formed at the end of the magmatic stage, that the slight alteration of the hypersthene took place after the introduction of the ore-minerals, and that none of the sulfids have undergone rearrangement of any kind.

Pyrrhotite Norite from the Stobie Mine.—We have studied a typical specimen of pyrrhotite norite from the Stobie mine. This rock constitutes a medium grade ore with large crystals of plagioclase, aggregates of tremolite, rims of hornblende, and sulfid masses. The general relations are shown in fig. 16. The light gray areas represented in the photograph are largely aggregates of uralite needles in more or less parallel position. These aggregates are often surrounded by hornblende. The probable explanation is that hypersthene was bordered by rims of horn-

blende, and at a later stage the hypersthene, but not the hornblende, underwent uralitization. From other data we know that the sulfids were formed after hypersthene and hornblende. A study of polished sections proves that the uralitization (tremolitization) occurred after the introduction of the sulfids, and as evidence we introduce figs. 17 and 18.

Fig. 18 shows pentlandite of the first generation in veinlike areas in the pyrrhotite, and pentlandite of the second generation developing along crystallographic directions of the pyrrhotite. The rearrangement of the ores is a very minor feature in this, as in the other Sudbury specimens.

The Rich Ores.—The massive ores examined by us show residual spots of rather "acid" material, consisting largely of alkali feldspar, quartz, hornblende, and biotite. In fact the gangue of the rich ore is more like the so-called micropegmatite than the quartz norite. Microcline is abundant, and is often intergrown with quartz. In none of the rich ores have we been able to find hypersthene. Its place seems to be taken by hornblende and biotite, which are probably late magmatic alteration products. It is difficult to believe that the "acid" rock is an older foot-wall granite. It is more probably a felsic differentiate of the same magma that furnished the norite.

Rich Ore from the Stobie Mine.—Rich ore from the Stobie mine is represented by fig. 19 (polished section). The chief minerals are plagioclase, quartz, and biotite. Garnet is also present. The ore-minerals, which occur in irregular masses occasionally extending out into veinlets, replace all the silicates including garnet. The replacement along cleavage lines of biotite by the chalcopyrite is beautifully shown in thin sections. This specimen is almost entirely free from alteration products. There is, however, a little chlorite in small lath-shaped sections, and these distinctly cut the ores.

Rich Ore from the Copper Cliff Mine.—On plate I (fig. 7) we show a large polished hand-specimen from this mine. This specimen shows silicates which are believed to be residual. The residual spots contain microcline and quartz (often in graphic intergrowth), plagioclase, biotite, a little hornblende, and long acicular crystals of apatite. As far as can be told from the residual matter which has escaped replacement, the rock is a granite. The ore-minerals, magnetite and pyrrhotite, replace the silicates, especially biotite, as is shown in fig. 20. The biotite gives one the impression of being one of the last formed silicates. There are also very small biotite crystals, which may possibly belong to a second generation. The apatite is also formed at a late stage.

There are a few alteration products present, such as chlorite and sericite, but they have nothing to do with the ores.

Rich Ores from the Creighton Mine.—The Creighton is the largest mine in the Sudbury district, and fortunately our suite of specimens includes a number from that deposit. The residual silicates in the ores are plagioclase, microcline, hornblende, and biotite. Hypersthene is lacking. Quartz is abundant as an interstitial mineral, and often occurs as a quartz-feldspar intergrowth.

On account of the abundance of quartz, one of the rich ores is practically a granite or possibly a grano-diorite. Another specimen very much resembles the quartz norite in structure, but hornblende is present instead of hypersthene. It is probable that this rock was originally a norite, and this indicates the possibility not only of late magmatic minerals but also of late magmatic rocks. The same specimen that furnished the thin section showing the norite texture also shows microcline and a subgraphic intergrowth of quartz and feldspar. This variation in the constituents within a small space is a characteristic of the igneous rocks containing magmatic ores.

A photograph of rich ore from the Creighton mine is shown in fig. 8 (plate I). This specimen furnished us the photomicrographs of figs. 25, 27-30, 32, and 33. A similar specimen furnished photomicrographs 23, 24, 31, and 34.

Polished sections showing the general relation of the sulfids to the silicates in these specimens are shown in figs. 27, 28, 31, and 32. Thin sections, which are necessary for the identification of the silicates, are represented by figs. 23 and 25.

The sulfids are later than the silicates. This is almost certain from the irregular hook-shaped anhedra which surround and occasionally project into the silicates; but if any doubt exists as to the later origin of the sulfids note the veinlets in plates V, VI, and VII. The veinlets replace almost indiscriminately the various silicates (see figs. 24, 28, and 30), but certain sulfid areas show marked selective replacement of the feldspar of the quartz-feldspar intergrowth, as in fig. 31. For an especially good illustration of replacement veinlet see fig. 24, where fresh biotite has been invaded by the sulfid. In fig. 26 a hornblende crystal has been cut squarely in two by a sulfid veinlet. Note the branching veinlets of figs. 28 and 30. The only explanation of these veinlets is that they are later than the silicates. The proponents of the magmatic theory for the Sudbury ores have ascribed these veinlets to rearrangement, and thus they reconcile their theories with microscopic work such

as that of Dickson. That the sulfid veinlets are of the same generation as the main sulfid masses and are not due to later rearrangement is shown in fig. 29, where the sulfids extend out into a veinlet without any break in the continuity or other evidence of later origin.

The late origin of the sulfid veinlets can hardly be doubted, but some may be inclined to suggest a hydrothermal origin for them. This is disproved by our findings. For example in the thin sections of the Creighton ore we found tremolite (and possibly talc) pseudomorphous after original hypersthene. The pseudomorphs contain minute magnetite crystals which were formed by alteration. The pseudomorphs are cut by veinlets of chalcopyrite, but the chalcopyrite has not wandered into the cracks of the tremolite. This shows that the hydrothermal alteration of hypersthene to tremolite (or talc) and magnetite occurred after the introduction of the chalcopyrite.

That the magnetite, as well as the sulfids, is formed at a late magmatic stage is indicated by fig. 20. The magnetite contains included ilmenite plates as illustrated by fig. 21. This magnetite-ilmenite intergrowth is a characteristic feature of magmatic ores.

Polished sections of massive, almost solid, ore from the Creighton mine are represented by figs. 22, 35, and 36. Fig. 22 shows an area of silicates which is doubtless a relict of the same granitic material present in the other Creighton samples. Magnetite has been replaced by the sulfids and the pentlandite has replaced pyrrhotite in vein-like masses. Veins of pentlandite are well shown in fig. 35; also minute tufts of brush-like crystals of a pale-yellow mineral, probably pentlandite of a second generation. Fig. 36 is a highly-magnified view of one of these crystals which extends out from a veinlet of chalcopyrite, probably of the second generation. Figs. 35 and 18 show what a minor amount of rearrangement has taken place in the typical magmatic ore of Sudbury.

At some of the Sudbury mines, notably the Worthington, certain sulfids which are not typically magmatic have been found. Among these minerals are pyrite and polydymite, but many others have been reported.[46]

We have examined several Sudbury ores containing pyrite. In fig. 37 is represented a supposed specimen of polydymite from the Vermilion mine. This contains pyrite in the form of veinlets evidently formed at a late stage. The relation of the polydymite to the magmatic sulfids is not entirely certain, but the examination of a very fresh speci-

[46] Barlow, A. E.—The nickel and copper deposits of Sudbury, Ontario. Geol. Surv. Can. Ann. Rept. 14, pt. H, 93 et seq.

men suggests that the Sudbury polydymite is a mixture of three minerals: pentlandite, an unknown violet-gray mineral, and the true polydymite. The polydymite and violet-gray mineral are probably due to the breaking down of the pentlandite.

One of the later sulfid ores from the Worthington mine is shown in fig. 38. Pyrite and sphalerite occur in a gangue of calcite. The pyrite has a peculiar reticulate structure. The sphalerite is later than pyrite.

The order of succession of the ore-minerals at Sudbury as determined in polished sections is as follows: (1) magnetite, (2) pyrrhotite, (3) pentlandite, and (4) chalcopyrite. The other sulfids, such as pyrite, sphalerite, etc., are post-magmatic.

Origin of the Sudbury Ores

With the possible exception of the gold-bearing "banket" of the Rand (South Africa), perhaps no other single group of ore deposits has received as much attention from the standpoint of origin as have the Sudbury deposits. Both the igneous and hydrothermal hypotheses of origin have had an almost equal number of advocates. Altho the earliest papers on the Sudbury deposits advocated the aqueous origin of the ores, opinion has been gradually crystallizing in favor of the magmatic origin, largely on account of the studies of Barlow, Coleman, and Walker, notwithstanding several vigorous protests, notably that of Dickson. However, the latest paper [47] on the subject reopens the whole question.

Our work substantiates many of the findings of Dickson [48] and of Campbell and Knight [49] relative to the Sudbury ores. We find, as they did, that the sulfids were formed later than the silicates, and verify Dickson's conclusion that the amount of hornblende increases as the ores become richer. With the exception that magnetite is later, not earlier, than the silicates, we agree with Campbell and Knight as to the order of formation of the ore-minerals.

We disagree with Dickson as to the hydrothermal ("secondary aqueous") origin of the ores.

We agree, on the other hand, with the supporters of the magmatic hypothesis that the ores were formed within the magmatic period. They were, however, not formed at an early stage and not by the sinking of the sulfid constituents.

[47] Knight, C. W.—Loc. cit.

[48] Dickson, C. W.—The ore-deposits at Sudbury, Ontario. Trans. Am. Inst. Min. Eng., 34, 3-67 (1903).

[49] Campbell, W., and Knight, C. W.—On the microstructure of nickeliferous pyrrhotite. Econ. Geol., 2, 350-356 (1907).

men suggests that the Sudbury polydymite is a mixture of three minerals: pentlandite, an unknown violet-gray mineral, and the true polydymite. The polydymite and violet-gray mineral are probably due to the breaking down of the pentlandite.

One of the later sulfid ores from the Worthington mine is shown in fig. 38. Pyrite and sphalerite occur in a gangue of calcite. The pyrite has a peculiar reticulate structure. The sphalerite is later than pyrite.

The order of succession of the ore-minerals at Sudbury as determined in polished sections is as follows: (1) magnetite, (2) pyrrhotite, (3) pentlandite, and (4) chalcopyrite. The other sulfids, such as pyrite, sphalerite, etc., are post-magmatic.

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[47] Knight, C. W.—Loc. cit.

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[49] Campbell, W., and Knight, C. W.—On the microstructure of nickeliferous pyrrhotite. Econ. Geol., 2, 350-356 (1907).

In fine, our work reconciles the almost diametrically opposite views of these two groups of investigators. Altho the ores are believed to be magmatic, they have been formed at the end of the magmatic period by the replacement of the silicates.

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THE ALEXO MINE, ONTARIO, CANADA

Geology

This occurrence of nickeliferous pyrrhotite, twenty miles southeast of Porcupine, Ontario, has been mentioned briefly by Coleman,[50] and described in detail by Uglow.[51] The geological relations are not disclosed on account of lack of exposure, and the mineralogical relations are complicated by an intense serpentinization. The ore occurs as a lens in serpentinized rock at the contact with rhyolite. In cases of this kind microscopic work is especially valuable. The unaltered rock is considered by Uglow to have been a peridotite of the wehrlite or harzburgite variety. The only exposure is in the immediate vicinity of the ore body, and developments are not sufficient to show the structural relations.

Uglow's Conclusions

Uglow examined the ore in both thin and polished sections, has shown the relations in photographs, and has brought out in a convincing way the phenomena of replacement as shown by his microscopic study. He states that the ore (pyrrhotite, pentlandite, chalcopyrite) "eats its way through the matrix of the serpentine" . . . "replaces it, forming a network of ore" . . . "extends between the crystals into fractures and cracks in the latter" . . . that "ore replaces part or all of an olivine crystal" and produces pseudomorphs—"magnetite pseudomorphs

50 Coleman, A. P.—The Alexo nickel deposit. Jour. Geol., **5**, 373-376 (1910).

51 Uglow, W. L.—A new nickel occurrence in northern Ontario. Jour. Can. Min. Inst., **14**, 657-677 (1911).

which have resulted from the alteration of the olivine, have become partly or wholly replaced by pyrrhotite," etc.

He finds that the order of the formation of the ore-minerals is (1) magnetite, (2) pyrrhotite, (3) pentlandite and chalcopyrite; and remarks: "It is difficult to conceive of the sulphides as differentiations from a molten magma when they are as a matter of fact deposited one after the other, the younger ones occurring as vein-like masses in the older."

His work is incomplete in that he does not investigate what portion of the phenomena of replacement and ore migration is to be connected with serpentinization, and what portion with the first deposition of the ores prior to serpentinization. Lindgren [52] states: "Here, as in so many other cases, secondary changes seem to have been confused with primary deposition."

We have, therefore, investigated in detail the relative amount of transfer and migration that is connected with serpentinization, and have been able to show that the phenomena of replacement mentioned above antedate serpentinization, and are connected with the original deposition of the ores.

Microscopic Description

Polished sections of ore of the Alexo mine kindly furnished by Mr. F. H. Mason of the Canadian Government Exhibition Commission, show pyrrhotite with minor amounts of pentlandite and chalcopyrite in a gangue of serpentine. The serpentine is the result of alteration of olivine. The general relations of the minerals are shown in fig. 39. Residual cores, apparently of olivine, prove to be serpentine upon examination of the thin sections. See also fig. 40, which is an enlargement of a portion of fig. 39. The section shown in figs. 39 and 40 was polished to bring out the silicates. On the other hand, the surface shown in figs. 41-44 was polished especially for the sulfids. Pentlandite occurs in fair amounts rather evenly distributed through the ore, with a tendency to alignment along crystallographic directions of the pyrrhotite which it replaces. The other sulfid present is chalcopyrite, which occurs in two, or possibly three, generations. In fig. 41 there is a little magmatic chalcopyrite and pentlandite. The serpentinization has been accompanied by a migration of nickel to form a second generation of pentlandite along veinlets (fig. 42), and of copper to form a second generation of chalcopyrite (fig. 44). The minute euhedral crystals of chalcopyrite shown in fig. 44 may pos-

[52] Lindgren, W.—Mineral Deposits, 765.

sibly represent a third generation of chalcopyrite. Altho there has been extensive alteration of the silicates in the Alexo ore, microscopic study shows clearly (see especially fig. 43) that this alteration was subsequent to the main period of ore formation and that the migration of ore during serpentinization was relatively slight.

SUMMARY

Summarizing the stages in the Alexo ore deposit we have (1) the formation of pyrrhotite, pentlandite, and chalcopyrite in the order named, at the end of the magmatic period, probably by selective replacement of the ground-mass of a picrite (pseudo-porphyritic peridotite); (2) the alteration of olivine and possibly of other silicates to serpentine; (3) accompanying the serpentinization there was a slight migration of copper and nickel to form second generations of chalcopyrite and pentlandite respectively, and also the formation of magnetite in very minute crystals and veinlets.

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THE FRIDAY MINE, SAN DIEGO COUNTY, CALIFORNIA

The occurrence of nickel ores in the Friday mine, San Diego county, California, was reported by Merrill[52a] and described by Calkins,[52b] whose paper furnished the geological data summarized in the following paragraphs:

The mine is four miles from the town of Julian, which lies halfway between San Diego and the Salton Sea. It is located on the crest of the broad range which forms the northern extension of the Cordillera of Lower California.

[52a] Merrill, F. J. H.—Geology and Mineral Resources of San Diego and Imperial counties. California State Mining Bureau Report, biennial period 1913-1914, p. 40.

[52b] Calkins, F. C.—An occurrence of nickel ore in San Diego county, California. S. Bull. 640, U. S. Geol. Surv., 77-82 (1916).

The complex batholith of Lower California extends into San Diego county, and the granitic rocks of the region are probably closely related to the larger masses to the south. Metamorphosed sediments are included within the granite, and near the mine a mass of gabbro of unknown size lies in contact with mica schist.

The ore occurs as a shoot or lens at the contact of the gabbro with the schist. The latter dips steeply southward, and the ore lies at the base of the gabbro. Considerable fracturing is reported in the vicinity of the ore body, and the ore is penetrated by a small pegmatite dike containing conspicuous crystals of tourmaline.

Microscopic Description

Thru the kindness of Mr. Beecher Sterne, president of the Friday Copper Mines Company, we obtained a suite of rocks and ores from the Friday mine, including specimens from the recently developed lower levels. The rock is an olivine gabbro with plagioclase ($Ab_8\ An_7$ in one section), olivine, and both orthorhombic and monoclinic pyroxene. A pale brown hornblende occurs as rims around the border of, and as patches within, the pyroxene. The hornblende is in parallel position with the pyroxene, and is doubtless a magmatic alteration product. Small tremolite prisms replace the pyroxene and plagioclase. Another alteration product is calcite, which occurs in veinlets and occasionally in zonal crystals.

The polished sections of the massive ores consist largely of pyrrhotite with residual spots of silicates. Associated with the pyrrhotite is a considerable amount of pentlandite. Calkins reported this as polydymite, but it has the characteristic cleavage, relief, and color of pentlandite. Chalcopyrite in small amounts is also present in the sections, and is distinctly later than the pyrrhotite and pentlandite. A second generation of pentlandite is developed along cracks in the pyrrhotite. A brass-yellow mineral occurs in veinlets and reticulate masses as a replacement of pyrrhotite. This was called pyrite by Calkins, but more probably it is marcasite. The marcasite gives the impression of being a very late mineral. It is usually extensively developed along calcite veinlets which occur as a net of intersecting stringers cutting all the other minerals. The polished sections also show that tremolite is later than the sulfids.

Summary

In the Friday deposit we have the following sequence of events: (1) The crystallization of olivine, pyroxenes, and plagioclase. (2) A slight development of hornblende by magmatic alteration. (3) The

formation of pyrrhotite, pentlandite, and chalcoypribe in the order named by the replacement of the above mentioned silicates. (4) The development of tremolite as a hydrothermal mineral and the development of pentlandite of a second generation in cracks in pyrrhotite. (5) The extensive development of calcite and marcasite veinlets.

With the exception of the marcasite and calcite this deposit is similar in mineral composition and paragenesis to magmatic deposits of this type.

THE GOLDEN CURRY MINE, ELKHORN, MONTANA[53]

Geology

An interesting deposit of magmatic gold- and copper-bearing pyrrhotite (non-nickeliferous, however) occurs in a marginal "basic" segregation of the Boulder quartz monzonite batholith. The deposit thus differs from the normal type of magmatic pyrrhotite deposits in respect to the geological relations and the character of the mother rock. The mineral composition, the inclusion of the ore in a subsilicic rock, and the relatively unaltered condition of the ore and country rock, give this deposit the characteristics of a magmatic ore. It is possibly the unmetamorphosed equivalent of the lenses of pyrrhotite in "basic" layers of gneiss, and is an indication that certain of these puzzling occurrences are altered magmatic segregations.

The Boulder batholith is well known to students of ore deposits because it was accompanied and followed by extensive mineralization, and especially because it encloses the enormous copper deposits at Butte.

The Golden Curry mine at Elkhorn is in a region of intense mineralization,[54] which occurred in and near the roof of the batholith. In this property there are two types of ore deposits: (1) a contact deposit between quartz monzonite and limestone, consisting of magnetite and some chalcopyrite accompanied by garnet; (2) the magmatic pyrrhotite deposit. The latter occurs 250 feet from the contact mentioned above, as the sulfid rich portion of a lens of fresh monoclinic pyroxene, pyrrhotite, and chalcopyrite. This is surrounded by a border zone, which grades into the normal quartz monzonite by the addition of, first, plagioclase, then hornblende, quartz, and the accessory minerals of the quartz monzonite, and finally biotite and orthoclase. According to

[53] Knopf, A.—A magmatic sulphide ore-body at Elkhorn, Mont. Econ. Geol. 8, 323-336 (1913).

[54] Knopf, A.—Ore deposits of the Helena mining region, Montana. Bull. 527, U. S. Geol. Surv. (1913).

Knopf, the deposit is characterized by the absence of pneumatolytic or hydrothermal alteration products. In the vicinity, however, intense pneumatolytic action is shown in the Queen mine, the ore of which is argentiferous galena, accompanied by quartz and tourmaline. Strong mineralization of a later cooler phase is also represented in the highly productive Elkhorn mine. The ore is a replacement deposit in dolomite, consisting of argentiferous galena unaccompanied by metasomatic gangue minerals.

The Boulder batholith develops in places a border zone distinctly more basic than the normal quartz monzonite. The ore deposits, however, with the exception of the Golden Curry mine, are connected with the "acid" differentiation products, as emphasized by Billingsley.[55] Aplite masses, aplite and pegmatite dikes, often accompanied by tourmaline and sulfids, are well developed in and near the roof of the batholith. Contact deposits are common, with axinite, tourmaline, etc., in addition to the usual minerals. Tourmaline-copper and tourmaline-lead-silver ores are the high-temperature phases brought about by the mineralizing action of the intrusive. It is therefore of considerable interest to know whether the "basic" segregation of the Golden Curry mine was formed at an early or a late stage. Was there a gap between the magmatic deposits and the later high-temperature phase so extensively developed in this region?

Microscopic Description

Mr. Adolph Knopf of the United States Geological Survey has kindly furnished us with thin sections of the pyrrhotite-augite ore from the Golden Curry mine. The rock is practically a pyroxenite, consisting mainly of monoclinic pyroxene (augite) and pyrrhotite, with minor amounts of hornblende, tremolite, and chalcopyrite.

The replacement of pyroxene by the pyrrhotite and chalcopyrite is well shown in fig. 45. The ore-minerals not only surround the pyroxene, but occasionally cut straight across a pyroxene crystal, as shown a little to the left and below the center of the photograph. The replacement of the pyroxene by the sulfids is also proved by fig. 47, for the small pyroxene crystal near the center is cut in two by a veinlet. The pyroxene has been altered to green hornblende (not uralite) in occasional patches (the darker gray spots in figs. 45 and 47). Definite proof that the sulfids are later than the hornblende and replace it along cleavage lines is shown in the lower portion of fig. 46. Tremolite is

[55] Billingsley, P.—The Boulder batholith of Montana. Tras. Am. Inst. Min. Eng., 51, 31-56 (1915).

formed at a still later stage, for as shown in fig. 47, it projects from the end of a hornblende crystal into the sulfids.

We agree with Knopf that the pyrrhotite-chalcopyrite ore of the Golden Curry mine is a magmatic deposit showing very little post-mineral alteration, but we believe that the sulfids were formed at a late magmatic stage, and after the partial magmatic alteration of pyroxene to hornblende.

PROSPECT HILL, LITCHFIELD, CONNECTICUT

An interesting series of sulfid-bearing igneous rocks varying from gabbro and norite to peridotite and pyroxenite was described by Hobbs [56] from this locality. Extreme magmatic differentiation has produced a great variety of rock types within a small area.

Recently Howe [57] has studied the relation of the sulfids to the silicates in these rocks. He identifies pyrrhotite, pentlandite, and chalcopyrite, which were formed in the order named. A prominent feature is the presence of hornblende and biotite as magmatic alteration products of pyroxene, but no mention is made of any post-magmatic alteration. Howe concludes that the ore-minerals mentioned are magmatic sulfids which separated for the most part at an early stage in the cooling of the magma, but remained liquid until the silicates had crystallized. He believes, however, that the sulfid veinlets in the silicates were formed by the replacement of the latter.

Dr. Howe has kindly sent us some specimens of these interesting sulfid-bearing rocks, and we have corroborated nearly all of his findings. The Litchfield sulfids are magmatic sulfids, if such exist. There is no evidence of any rearrangement of the ore-minerals. The veinlets do not belong to a later generation, and all the ore-minerals are late magmatic. Altho the rocks are exceptionally fresh, perhaps more so than the average unmineralized igneous rock, we find some serpentinization of the olivine. This is especially well shown in the polished sections.[58]

We find that there has been slight post-magmatic alteration of the silicates, but conclude with Howe [59] "that the relations of the sulphides to one another were . . . determined during the magmatic period."

[56] Festschrift Harry Rosenbusch, 25-48. Stuttgart, 1906.

[57] Howe, E.—Sulphide-bearing rocks from Litchfield, Conn. Econ. Geol., **10**, 330-347 (1915).

[58] The alteration products are very apparent in well polished sections, tho of course the identity of the minerals must be determined in thin sections or crushed fragments.

[59] Loc. cit., 339.

KNOX COUNTY, MAINE

Bastin [60] has described in detail a pyrrhotitic peridotite from this locality. The peridotite is thought to be a differentiate of granite. Chalcopyrite and pyrite are associated with the pyrrhotite, but the relation of the pyrite to the other ore-minerals is not discussed. Hornblende is locally important, and occurs both as crystals and as rims between feldspar and olivine. The secondary alteration (serpentinization) is later than the ore. His photographs show pyrrhotite surrounding the olivine and penetrating it in embayments.

This is evidently a typical magmatic deposit, with the ore later than the primary silicates.

MOUNTAIN, WISCONSIN[61]

This deposit occurs in a basic dike 60 to 200 feet wide. The ore is massive pyrrhotite which "merges into gabbro on indefinite lines." The author does not give the results of a careful field study, and no microscopic investigation of the rock or ore is recorded.

OTHER PYRRHOTITE DEPOSITS IN THE UNITED STATES

In addition to its occurrence in the magmatic ores, pyrrhotite is also found in other high-temperature deposits. Among these are the lenticular ore-bodies found in gneisses and schists. Those in the basic portion of the gneiss may be magmatic in origin, and those in the acid layers may be related to "acid" or pegmatitic extracts. Altho some of the pyrrhotite deposits occurring in metamorphic rocks, for example that of the Gap mine, Lancaster, Pennsylvania,[62] have been assigned to the magmatic group, most of them have been so modified by intense metamorphism that they no longer show the characteristics of typical magmatic deposits.

INSIZWA RANGE, EAST GRIQUALAND, SOUTH AFRICA

Our knowledge of the deposits near the town of Mount Ayliff, in Cape Colony, is due chiefly to the excellent, tho brief, report of Du

[60] Bastin, E. S.—A pyrrhotitic peridotite from Knox county, Maine. Jour. Geol., 16, 124-138 (1908).

[61] Bagg, R. M.—The discovery of pyrrhotite, with a discussion of its probable origin by magmatic differentiation. Econ. Geol., 8, 369-373 (1913).

[62] Kemp, J. F.—The nickel mine at Lancaster Gap, Pennsylvania, and the pyrrhotite deposits at Anthony's Nose, on the Hudson. Trans. Am. Inst. Min. Eng., 24, 620-633 (1894).

Toit.[63] He has discussed in a satisfactory manner the general geology and the petrography of the region. His microscopic description of the ores is brief, and it is chiefly in this respect that further information is needed. Unfortunately we have not been able to procure specimens from these deposits.

The deposits show certain similarities to those of the Sudbury district. The ore-minerals are the same, and they occur at the base of a large "basic" sill. They differ from the Sudbury deposits in certain respects, however, and features that are hidden at Sudbury are exposed by the erosion of the mountain mass of the Insizwa range. Du Toit's results are summarized in the following paragraphs.

Interest has been aroused in these deposits, first, by the discovery of copper, then nickel, and recently of platinum. The ores consist of pyrrhotite, pentlandite, chalcopyrite, with some pyrite, niccolite, and a platinum mineral, probably sperrylite. The ores occur at the base of the largest of a series of sills of olivine gabbro and olivine norite. The country rock, therefore, is more "basic" than the Sudbury "nickel intrusive." At this locality an extensive series or group of sills occurs in the Beaufort shales and sandstones of the Karoo system. The sills are flat-topped, but the under surface is funnel-shaped, narrowing down into the feeding dikes. Strange to say, the intruded shales are not tilted but are "undisturbed and almost absolutely flat, bounded by an under regularly curved surface of fractures."

The ores are intimately mixed with the silicates and "intrude" the country rock to some extent. The silicates of the sill show no alteration where they adjoin the ores. In addition to the ores, a granitic extract has been segregated along the base of the sill. This occurs as a network of dikes and dikelets, from a fraction of an inch to a foot in thickness. Intense contact action has affected the sedimentary rocks, and seems to be closely related to the dikes. The product of the contact metamorphism is a hornfels, described as a quartz-cordierite-feldspar rock with abundant biotite and enstatite in places. In the calcareous layers epidote, zoisite, diopside, enstatite, wollastonite, and garnet are developed.

Du Toit's figure[64] shows relations similar to those we have found in the magmatic ores from other localities, and which we interpret as indicating a replacement of the gangue by the ore-minerals. Du Toit

[63] Du Toit, A. L.—Report on the copper-nickel deposits of the Insizwa, Mount Ayliff, East Griqualand, Cape of Good Hope. Dept. Mines, 15th Ann. Rept. of the Geol. Comm., 111-142 (1910).

[64] Loc. cit., fig. 4, p. 139.

makes the order of formation of the sulfids the reverse of that determined by Campbell and Knight for the Sudbury deposits. An examination of Du Toit's sketch [65] shows the same marginal relations of chalcopyrite to the other sulfids as found in Sudbury, and we venture to suggest that further microscopic study of the ore will show that the order of the formation of the sulfids is the same at Mount Ayliff as in all other known deposits of this type.

Summarizing, we find the following suite of events connected with intrusion and ore formation at Mount Ayliff:

(1) The intrusion of a complex family of "basic" sills connected by cross-cutting dikes.

(2) The crystallization of the silicate minerals of the gabbro and norite.

(3) The development of the sulfid ores in certain localities in the basal portion of the largest of the sills by replacement of the silicates, but unaccompanied by the development of secondary silicates.

(4) The squeezing out of a granitic extract, forming a complex set of small dikes at the base of the sill, and the development of intense contact metamorphism due to gases accompanying the "acid extract." Ore formation also occurred in this stage, as ore-minerals are found in the pegmatite and granitic dikes.

NORWAY

Geology

In Norway, Nature has constructed a series of small-scale models to illustrate the type of nickel, copper, and iron sulfid deposits of magmatic origin. These instructive examples have been described in detail by Vogt,[66] whose classic work has established the existence and characteristics of this type of ore deposits. In as much as a part of the microscopic data admit of explanation according to Vogt's hypothesis of an intrusive sulfid magma, we discuss in some detail his conclusions as to the origin of these ores.

In many of the Norwegian occurrences neither the ore nor the norite has suffered metamorphism, and the geological relations are simple, so that it seems possible to select the phenomena that are characteristic of this type of deposits. It is essential for an understanding of the problems that this be done, for in many of the deposits of nickeliferous pyrrhotite elsewhere the data are either wanting or not easily

[65] Loc. cit., fig. 3, p. 137.

[66] Cited, p. 5.

deciphered. At Sudbury, for instance, it is difficult to compile the story of ore formation from the geologic records, overcrowded with the details of the eventful igneous and metamorphic history of which ore deposition is a mere episode. There, inclusions of mafic material may be explained either as "basic" segregations or as inclusions of "the older norite," as best suits the hypothesis favored by the individual investigator. Felsic masses and dikes are variously explained as inclusions of an older granite, as "acid" segregations of the norite, or as a distinctly younger intrusive granite.

In addition to the little altered types, some of the Norwegian deposits are modified by subsequent metamorphism, and in others the ores are accompanied by metasomatic borders of garnet (fig. 5). Hydrothermal alteration with the formation of pyrite appears to be developed where pegmatitic intrusions are numerous and active mineralizers were present (fig. 3).

These gradation types are fully as instructive as the normal occurrences, and support our contention that the typical magmatic deposits are one phase of high-temperature deposition, and changes in the character of the mineralizers result in gradations towards the other types.

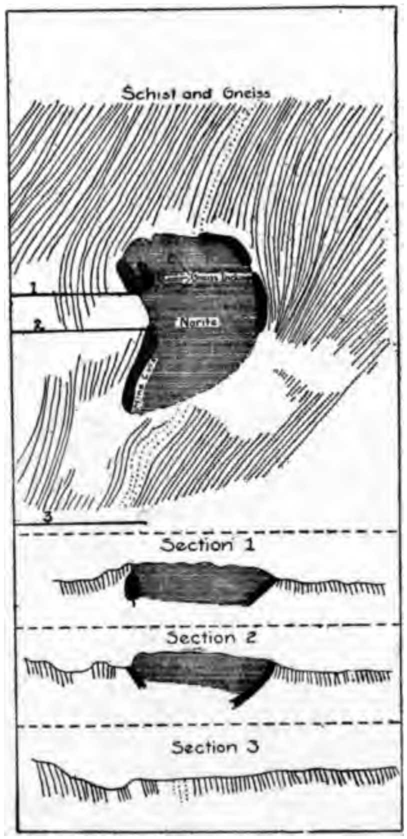

Fig. 2. Meinkjär mine, Norway. (Distance across sketch about 500 ft.) (After Vogt, Zeit. f. prakt. Geol., plate VI, fig. 3, opposite p. 133, Jahrgang 1893.)

In Norway there are about fifty deposits of pyrrhotitic copper-nickel ores which occur exclusively at or near the margins of small norite or gabbro stocks. The stocks are round or elliptical in outline, and some are funnel-shaped in cross-section. Figs. 2 and 3, taken from Vogt, illustrate typical occurrences. The individual intrusives are small, rarely exceeding a few hundred feet in diameter, and the amount of ore in each stock is roughly proportional to its size.

Petrography and Mineralogy

The ore-bearing rock may be classed broadly as norite ($\pm$ quartz, olivine, and diallage), and in a few localities it is so extensively uralitized as to be classified by some authorities as a "gabbro-diorite." Each individual stock has undergone extensive differentiation, especially in the vicinity of the ore bodies. The basic segregations are mixtures of bronzite, hornblende, olivine, and biotite. They occur in masses, smaller inclusions, and, at Romsaas, as a peculiar orbicular norite. The felsic

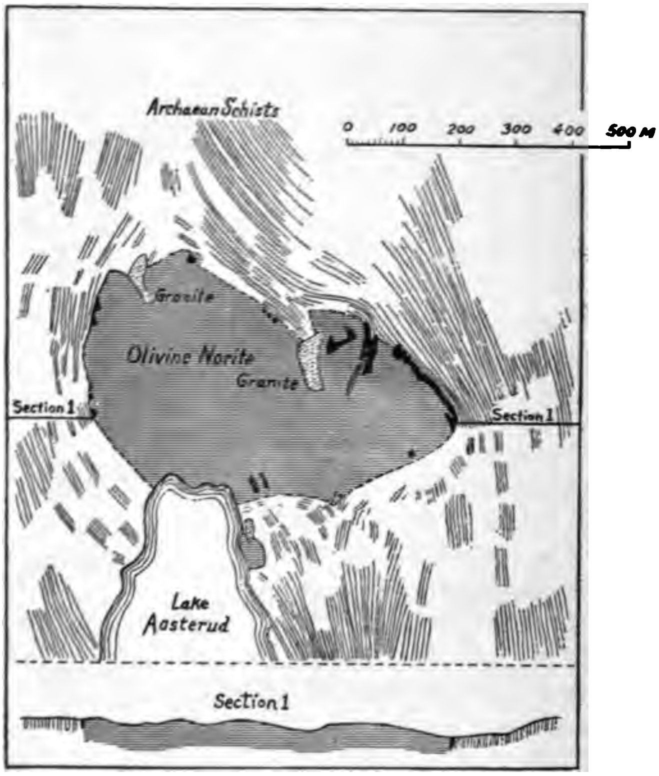

Fig. 3. Erteli mine, Ringerike, Norway. (After Vogt, Zeit. f. prakt. Geol., fig. 8, plate V, Jahrgang 1893.)

products of differentiation are as prominent as the mafic, and occur as masses of granite, streaks and dikes of pegmatitic and aplitic material, and small marginal veinlets of aplite and pegmatite. A similar differentiation appears to be a characteristic of all deposits of this class. The margins of the stocks often show severe fracturing and brecciation, and the ore may cement these igneous breccias, as at Sudbury.

According to our ideas, it would appear that (1) the "basic" portions of the norite solidified by the sinking of crystals; (2) portions of this "basic" material were caught up as inclusions in the normal norite, especially along the margins of the stocks; (3) the main mass of the rock crystallized as norite; (4) felsic dikes and masses were squeezed out as marginal segregates during a period of peripheral brecciation, which facilitated the concentration and escape of mineralizers from the deeper portions of the magma; (5) ore deposition, at a late stage, was preceded, accompanied, and followed, by the "acid" secretions, as the ore is found in the felsic dikes, is later than the silicates of the same, and the main ore masses are cut by the dikes.

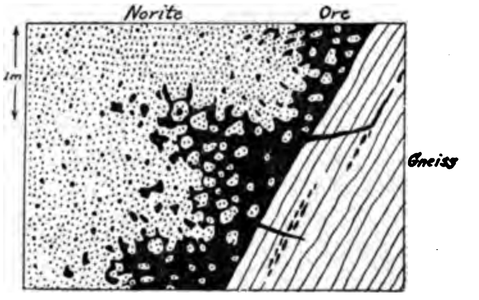

Fig. 4. Detailed cross-section of ore-body at the Meinkjär mine, Norway. (After Vogt, Zeit. f. prakt. Geol., fig. 29, p. 136, Jahrgang 1893.)

The ores occur chiefly at the margins of the stocks, and to a minor amount as segregations within the norite, and also as impregnations in the schists and gneisses in which the norite masses are enclosed. As has been mentioned, the ores are further localized where marked differentiation has taken place. At the Flaad mine, especially, the ores are closely related to felsic differentiates.

Fig. 5. Pyrrhotite gabbro from Erteli mine, Norway. Pyrrhotite veinlet cutting feldspar and diallage with rim of garnet. (x 100.) (After Vogt, *loc. cit.*, p. 139.)

Fig. 6. Pyrrhotite veinlets cutting hornblende. Flaad mine, Evje, Norway. (x 50.) (After Vogt, *loc. cit.*, p. 139.)

The ores show the same group of minerals (chiefly magnetite, pyrrhotite, pentlandite, and chalcopyrite), and the same relation to each other and to the schists, as we have found in the deposits studied elsewhere. Pyrite is mentioned by Vogt as of common occurrence in these

deposits. He describes it especially in the Erteli mine at Ringerike, and the Flaad mine at Evje. Ores from both these localities, furnished through the courtesy of Professor J. F. Kemp, were examined by us. The pyrite from Ringerike occurs as euhedral and irregular grains, cutting both the other ore-minerals and the silicates. Its position in the sequence of mineral formation could not be definitely determined from the material available. Pyrite, in the ore from Evje, however, clearly cuts garnet and also all the ore-minerals, including chalcopyrite, as groups of anastomising sub-parallel veinlets (fig. 48). These veinlets widen into irregular areas, and even subhedral crystals are often developed. This makes it probable that the euhedral and subhedral pyrite crystals of fig. 48, as well as the veinlets, are later than the pyrrhotite. Chlorite and calcite cut the sulfids in sharp veinlets, and occur along the pyrite veinlets. They are certainly later than all the sulfid minerals except pyrite, and may be later than it.

As already stated, pyrite is not commonly found in the magmatic ores. At Sudbury, it is found especially in the Worthington offset, connected with later veins of hydrothermal origin. In the Ringerike deposits ore has been mined from disseminations in the country rock, and the pyrite in these ores may have been developed in the schists prior to the introduction of the ores. At Evje, as stated above, the pyrite is the last sulfid mineral to form, and may have been developed during the extensive uralitization of the country rock. A complete microscopic study of all the Norwegian ores according to modern petrographic and metallographic methods is needed in order to determine the paragenesis of the pyrite.

As described and figured by Vogt (fig. 5), veinlets of sulfid ores are accompanied by garnet, showing a gradation of these deposits to other high-temperature deposits.

Contrary to the general impression, Vogt states that the ores in all cases are later than the silicates. He notes [67] the frequent occurrence of microscopic veinlets in the cracks and cleavage planes of the silicate minerals. We wish to emphasize again, that these data, checked by us, admit of only two explanations, viz., (1) that of Vogt, who postulates an intrusion of molten sulfids into the solidified rock; or (2), our hypothesis that the sulfids were formed by the replacement of silicates under the influence of mineralizers. This process, however, belongs to a late magmatic period, and not to destructive pneumatolytic or hydrothermal stages, and the deposits, therefore, may properly be designated as magmatic.

67 Zeit. f. prakt. Geol., Jahrgang 1893, p. 139.

Discussion of Vogt's Conclusions

In the light of the data summarized in the preceding pages we may now examine in detail the data listed by Vogt,[68] in his latest contribution, as favoring his hypothesis.

"As suggested more particularly by Vogt in 1893, the nickel-pyrrhotite deposits are to be regarded as magmatic segregations in gabbro or in chemically analogous dike rocks. The following points speak for such an origin:

1. The connection of the numerous deposits in different countries with occurrences of gabbro or exceptionally with equivalent dike rocks, is constant and regular.
2. The several occurrences so resemble one another not only geologically but also mineralogically that they must be of the same genesis throughout, while the unvarying character of the deposits postulates a simple process of formation.
3. Gradations between ore and gabbro through the intermediate stage of pyrrhotite-gabbro are often to be observed, and therefore the ore essentially must have been formed in a similar manner to that rock.
4. The structure of the clean or almost clean sulphide mixture with idiomorphic crystals suggests crystallization from a single magmatic solution, and not from several solutions following one another, as was evidently the case for example with the lead-silver-zinc lodes.
5. The deposits often occur in those parts of a gabbro mass which are distinguished by pronounced differentiation of the eruptive rock.
6. The deposits are sometimes crossed by dikes of basic rock, diabase, olivine-diabase, etc., which are to be regarded as later effusions of the same eruption of gabbro. The formation of the ore belongs therefore to the magmatic period of the rock in which it occurs.
7. Some of the deposits are traversed and accompanied by acid leucocratic streaks and dikes which represent the acid segregation products from the gabbro-magma, from which also it follows that the formation of the deposits took place during the magmatic period of the eruptive rock.
8. The characteristic presence of titanomagnetite allows a manner of formation analogous to that of the magmatic titaniferous-iron deposits to be postulated.
9. Pneumatolytic minerals are completely wanting.
10. The minerals usually formed in the wet way are not present as part of the primary formation."

The points in paragraphs 1 and 2 are verified by our work. The ores are so closely connected with a particular type of basic rock

[68] Ore Deposits: Beyschlag, Vogt, and Krusch; Translated by S. J. Truscott; pp. 286-287. We have revised the translation slightly for the sake of accuracy.

that a genetic relation cannot be doubted. The majority of the deposits are so similar that one method of ore formation alone is involved. The various complicated sets of minerals produced by hydrothermal solutions are either lacking or are developed after the formation of the ores, and hence a close relation to rock crystallization is suggested.

Paragraph 3 has little meaning. Variations in amount of replacement, from incomplete to complete, are found in most ores formed by this process.[69] The same relations obtain in magmatic ores.

In regard to paragraph 4, Vogt is in error as to the facts. Apparently he had not studied polished ore surfaces, nor has he grasped the meaning of the data set forth in the articles by Dickson[70] and by Campbell and Knight.[71] The ores of the magmatic stage are introduced into the completely crystallized rock, one after the other, in the following order: (1) magnetite and ilmenite, (2) pyrrhotite, (3) pentlandite, and (4) chalcopyrite. There is positive evidence of a certain amount of the replacement of the earlier ore-minerals by those introduced at later stages. This replacement cannot be explained by corrosion, for there are no intermediate reaction products. The replaced minerals are completely removed by the same agencies that brought in the ores. Vogt recognizes that some of the chalcopyrite is later than the other oreminerals. He states:[72] "Die häufig beobachtete Anreicherung des Kupferkieses, namentlich in den peripheren Teilen der Nickel-Magnetkieslagerstätten muss auf eine besondere magmatische Differentiation innerhalb der Sulfidmagmen beruhen."

To apply his ideas to the facts now established, he would have to postulate a triple or quadruple differentiation within the sulfid magma.

The points in paragraphs 5, 6, and 7 are verified and emphasized by us. Magmatic differentiation is characteristic of the orebearing norite, and is especially marked in the vicinity of the ores. Extensive early differentiation calls for an equivalent development of the complementary later differentiation. The ores are a phase of the latter. They are extracted from the magma basin by mineralizers, and are brought to the margin of the deposit and deposited without the development of secondary silicates.

Point 8 is valid.

[69] Knight (loc. cit.) emphasizes this in his recent discussion of the Sudbury ores.

[70] Loc. cit.

[71] Loc. cit.

[72] Beyschlag, Krusch, Vogt.—Die Lagerstätten der nutzbaren Mineralien und Gesteine. Band 1, 284-285 (1910).

Point 9 is true in general, altho tourmaline and garnet are occasionally present and hornblendization generally precedes ore deposition. Vogt evidently assumes that high-temperature deposits formed by mineralizers must be accompanied by destructive pneumatolysis. In this regard it is interesting to note that Vogt's early studies led him to suggest a "combination magmatic segregation with pneumatolysis, according to which metalliferous vapors evolved from the magmas in one place were decomposed in another, depositing the ore in rock already consolidated."[78] It is needless to state that his early concept approached more closely to the truth than his present hypothesis.

Paragraph 10 may be more accurately stated as follows: The secondary silicates usually formed by destructive pneumatolysis and hydrothermal action are not developed in the magmatic stage of ore formation.

Summary

We conclude with Vogt that the ores are so closely related to the intrusive rocks which contain them, and to the processes of rock differentiation, and differ so markedly from deposits formed by pneumatolytic and hydrothermal processes, that they should be classed as magmatic. However, they cannot be considered as segregated in the molten stage by a "liquation" process, and at a later date intruded into the silicates, for the following reasons:

1. The ore-minerals are formed in an orderly sequence, one after the other. A succession of sulfid differentiations and intrusions is beyond the realm of probability.

2. The ores replace the country rock without reaction rims, and the silicates thus replaced have been completely removed.

3. The minerals are introduced after the magmatic alteration of pyroxene to hornblende, but probably prior to the intense uralitization certain of the deposits have undergone.

4. The temperature of the late stages of differentiation in the presence of mineralizers, and the formation of pegmatite and aplite dikes, is far below the temperature of molten ores, as we know them as furnace products.

5. The phenomena of ore formation and rock replacement are similar in all respects to that of sulfid ore deposition from hydrothermal solutions, except for the comparative absence of secondary silica and silicates. This is a characteristic feature of this type of ore, and is due to the conditions of chemical equilibria under which they are formed.

[78] Truscott trans. Loc. cit., 289.

Bibliography of the Norwegian Deposits

Vogt, J. H. L.—Bildung von Erzlagerstätten durch Differentiationsprocesse in basichen Eruptivmagmata. Zeit. f. prakt. Geol., Jahrgang 1893, pp. 4-11, 125-143, 257-284.

See also Stelzner-Bergeat, Die Erzlagerstätten, I, 48, 1904, for literature of the Norwegian occurrences.

OTHER EUROPEAN OCCURRENCES

Sweden

The nickel- and copper-bearing pyrrhotite deposits of Sweden are similar to the more extensive group in Norway. They appear, in general, to have suffered greater alteration than the latter. The largest deposit is at Klefva, in Småland. The ores occur in a quartz norite which has suffered intense uralitization. Some deposits at Kuso and Stattberg occur in mafic (diabase) dikes, and are somewhat similar to the occurrence at Sohland mentioned below.[74]

Baden, Horbach, and Todtmoos, Germany

In the southern Black Forest pyrrhotitic ores occur in small amount in basic inclusions and dikes, extensively altered to amphibolite and serpentine, which occur in granite and gneiss. They are cut by granite-aplite dikes.[75]

Sohland and Sweiderich on the boundary between Saxony and Bohemia

Nickel- and copper-bearing pyrrhotite[76] impregnates the footwall of irregular "basic" dikes which are varied in composition on account of pronounced differentiation.

The ores, according to Beck, surround and cut corroded augite, hornblende, and biotite, and shatter and impregnate the latter. Beck was

[74] Literature is cited, Beyschlag, Krusch, Vogt, I, p. 294, and Stelzner-Bergeat, I, p. 48.

[75] Weinschenk, E.—Die Nickelmagnetkieslagerstätten in Bezirk St. Blasien. Zeit. f. prakt. Geol., Jahrg. 1907, pp. 73-86. Other literature cited in the textbooks of Beck and Stelzner-Bergeat.

[76] Beck, R.—Die Nickelerzlagerstätten von Sohland a. d. Spree und ihre gesteine. Zeit. deutsch. geol. Ges., Jahrg. 1903, pp. 296-331. (Includes bibliography of the older literature.)

——Lehre von Erzlagerstätten, I, 81-86 (1909).

von Foullon, H. B. Über einige Nickelvorkommen. Jahrb. k.k. geol. Reichsanst. 302 pp. Wein. (1892).

unable to distinguish pentlandite from pyrrhotite, but we found no difficulty in showing its existence in polished surfaces (see figs. 50 and 51, plate XII).

Beck has proved conclusively that the ores are later than the primary silicates, and believes that they are formed by a "post-volcanic, pneumatolytic phase of rock building." [77]

We have a small suite of specimens from Sohland which include both the unaltered rock and ores. These we have examined in thin sections, and the ores also in polished sections. The unaltered rock is a hornblende-diabase (called proterobase by Beck), containing plagioclase, augite, brown hornblende, biotite, apatite, titanite, and magnetite. The only alteration products present are a little calcite, tremolite, and chlorite. The hornblende occurs in parallel position with the augite and is evidently a late magmatic mineral.

In thin sections of the ore the only original silicate mineral noted is the hornblende. The feldspars and biotite are altered almost beyond recognition. The alteration products are chlorite, sericite, and uralite. Of especial interest is the uralite, because its relation to the ore-minerals can be definitely established.[77a]

Fig. 50 shows the general relations of the minerals in the polished sections. A study of our sections together with Beck's original figures (especially his fig. 4 of plate XIII) makes it almost certain that the ore-minerals were formed later than the hornblende, but earlier than the uralite. Uralite develops on the ends of the hornblende prisms in parallel position, and occasionally completely replaces the hornblende. Frequently the uralite needles project out into the ore-minerals, as in fig. 51, and in Beck's fig. 4. This affords conclusive evidence of post-mineral alteration. For this reason we believe that the Sohland ore is magmatic in spite of the extensive alteration. The relation of the ore-minerals to the silicates was evidently established during the magmatic period, and not modified by later hydrothermal action.

[77] Quoted by Berg, opus cit., 108.

[77a] In the literature the term uralite has been used in two senses, (1) for hornblende rims around pyroxene, (2) for the fine fibrous aggregates of tremolite (including actinolite). The first usage we have avoided entirely, and in the few cases in which the terms uralite and uralitization are used by us, these are to be given the second meaning. The hornblende rims appear to be late magmatic and the tremolite a post-magmatic, hydrothermal mineral.

The minerals of the hypersthenite are comparatively fresh, but there has been some alteration along the boundaries between the hypersthene anhedra. This alteration product of hypersthene is probably anthophyllite. It occurs in fibrous aggregates which are often intimately associated with the bornite. Fig. 55 is a photomicrograph of an area showing the relations of the anthophyllite to the bornite. A careful study of the section shows that the anthophyllite has replaced the bornite. The narrow linear areas of bornite might be considered evidence that the bornite had replaced anthophyllite; but that the reverse is true is proved by the obliquely-cutting anthophyllite needles shown at several points.

Ore-bearing Norite from the Tweefontein Mine.—Sections of ore-bearing norite from the Tweefontein mine are represented on plates XIV and XV. The silicate minerals are hypersthene and plagioclase, with subordinate biotite. The ore-minerals are magnetite, chalcopyrite, and bornite. Fig. 56 illustrates the replacement of hypersthene by ore-minerals, principally magnetite with a little bornite and chalcopyrite. At the bottom of the photograph there is a small magnetite crystal, which is anhedral along the border between the hypersthene and plagioclase and euhedral within the plagioclase crystal. This is better shown in fig. 57.

In fig. 58 the opaque mineral is largely bornite, with a little chalcopyrite and magnetite. At the bottom of the figure a hypersthene crystal is almost completely surrounded by bornite. A higher magnification of the upper left corner of this area is shown in fig. 59. The bornite has replaced the plagioclase in the direction of twinning lamellae.

Figs. 60-63 (plate XV) show the occurrence, in the Tweefontein norite, of the ore-minerals in polished sections. The general relations are shown in fig. 60. Magnetite and hematite are readily distinguished by the character of their surfaces (fig. 61). Magnetite is rough and is intergrown with ilmenite; hematite is smooth. Magnetite and hematite, as well as the sulfids, surround and replace the silicates. The replacement of biotite by the sulfids is well shown in fig. 60. Note the veinlike magnetite which cuts directly through a hypersthene crystal.

The norite specimens from the Tweefontein mine are remarkably free from alteration, as can be seen from the photomicrographs. There was, however, a little alteration along minor fractures (fig. 62) in bornite. Along one of these fractures (illustrated by fig. 63) gashes of chalcopyrite of a second generation and minute crystals of anthophyllite were developed. The high magnification of these figures shows how insignificant is the alteration.

Another specimen of norite taken from drill-cores at the Tweefontein mine constitutes a lean ore. Very small amounts of bornite and chalcopyrite are visible. There is, however, considerable magnetite. A study of the thin section shows as good evidence of the replacement of the silicates as one could wish for. A small apatite crystal has been cut squarely in two by magnetite.

Ore-bearing Mica Diorite from the Ookiep East Mine.—There remains to be described the mica diorite from the Ookiep East mine. The principal minerals are plagioclase and biotite. The alteration products include anthophyllite, clinozoisite, and chlorite. The ore-minerals are magnetite, pyrrhotite, and chalcopyrite; bornite is absent. The mica diorite is poor in ore, and, strange to say, is more altered than that containing large amounts of chalcopyrite and pyrrhotite. Fig. 65 illustrates the occurrence of the ore-minerals in the rich ore as seen in thin section. The alteration veinlet (chlorite) at the bottom of the figure is later than the sulfids. The light spots within the opaque areas are also alteration products.

A study of the polished sections with a low-power microscope indicates that the chalcopyrite is probably formed by the replacement of the pyrrhotite (see fig. 64). Another spot furnishes evidence that the pyrrhotite has in part been formed by the replacement of magnetite (see fig. 67).

Some portions of the specimens of rich ore from the Ookiep East mine contain definite sulfid veinlets. These are shown in thin section in fig. 66 and in polished section in fig. 68. These veinlets, unlike the sulfid veinlets in the Sudbury ores, have a peculiar "fuzzy" appearance which (see fig. 66) suggests that they might have been produced by rearrangement of the larger sulfid masses. The study of the thin sections under high magnification shows that this appearance is due to the presence of a secondary silicate (chlorite or anthophyllite). That the veinlets are not due to rearrangement is proved by fig. 69, which distinctly shows that the alteration product, probably chlorite formed by the alteration of anthophyllite, is later than the chalcopyrite of the veinlets. Minute specks of a light yellow mineral, probably pentlandite (fig. 71), were also found in the ore from the Ookiep East mine. It is a late, probably hydrothermal, mineral, and furnishes the only evidence of rearrangement of the sulfids in our specimens of the ores of the Ookiep East mine.

The replacement of the silicates is shown in all the photographs in plates XVI and XVII, but especially well in fig. 70. This represents a

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In fig. 58 the opaque mineral is largely bornite, with a little chalcopyrite and magnetite. At the bottom of the figure a hypersthene crystal is almost completely surrounded by bornite. A higher magnification of the upper left corner of this area is shown in fig. 59. The bornite has replaced the plagioclase in the direction of twinning lamellae.

Figs. 60-63 (plate XV) show the occurrence, in the Tweefontein norite, of the ore-minerals in polished sections. The general relations are shown in fig. 60. Magnetite and hematite are readily distinguished by the character of their surfaces (fig. 61). Magnetite is rough and is intergrown with ilmenite; hematite is smooth. Magnetite and hematite, as well as the sulfids, surround and replace the silicates. The replacement of biotite by the sulfids is well shown in fig. 60. Note the veinlike magnetite which cuts directly through a hypersthene crystal.

The norite specimens from the Tweefontein mine are remarkably free from alteration, as can be seen from the photomicrographs. There was, however, a little alteration along minor fractures (fig. 62) in bornite. Along one of these fractures (illustrated by fig. 63) gashes of chalcopyrite of a second generation and minute crystals of anthophyllite were developed. The high magnification of these figures shows how insignificant is the alteration.

Another specimen of norite taken from drill-cores at the Tweefontein mine constitutes a lean ore. Very small amounts of bornite and chalcopyrite are visible. There is, however, considerable magnetite. A study of the thin section shows as good evidence of the replacement of the silicates as one could wish for. A small apatite crystal has been cut squarely in two by magnetite.

Ore-bearing Mica Diorite from the Ookiep East Mine.—There remains to be described the mica diorite from the Ookiep East mine. The principal minerals are plagioclase and biotite. The alteration products include anthophyllite, clinozoisite, and chlorite. The ore-minerals are magnetite, pyrrhotite, and chalcopyrite; bornite is absent. The mica diorite is poor in ore, and, strange to say, is more altered than that containing large amounts of chalcopyrite and pyrrhotite. Fig. 65 illustrates the occurrence of the ore-minerals in the rich ore as seen in thin section. The alteration veinlet (chlorite) at the bottom of the figure is later than the sulfids. The light spots within the opaque areas are also alteration products.

A study of the polished sections with a low-power microscope indicates that the chalcopyrite is probably formed by the replacement of the pyrrhotite (see fig. 64). Another spot furnishes evidence that the pyrrhotite has in part been formed by the replacement of magnetite (see fig. 67).

Some portions of the specimens of rich ore from the Ookiep East mine contain definite sulfid veinlets. These are shown in thin section in fig. 66 and in polished section in fig. 68. These veinlets, unlike the sulfid veinlets in the Sudbury ores, have a peculiar "fuzzy" appearance which (see fig. 66) suggests that they might have been produced by rearrangement of the larger sulfid masses. The study of the thin sections under high magnification shows that this appearance is due to the presence of a secondary silicate (chlorite or anthophyllite). That the veinlets are not due to rearrangement is proved by fig. 69, which distinctly shows that the alteration product, probably chlorite formed by the alteration of anthophyllite, is later than the chalcopyrite of the veinlets. Minute specks of a light yellow mineral, probably pentlandite (fig. 71), were also found in the ore from the Ookiep East mine. It is a late, probably hydrothermal, mineral, and furnishes the only evidence of rearrangement of the sulfids in our specimens of the ores of the Ookiep East mine.

The replacement of the silicates is shown in all the photographs in plates XVI and XVII, but especially well in fig. 70. This represents a

biotite-rich segregation in the diorite. The biotite, itself probably a late magmatic mineral, has been replaced along its cleavage planes by chalcopyrite. This produces a structure which can be distinguished from that developed by the replacement of the sulfids by later hydrothermal minerals such as sericite, chlorite, and tremolite. (See for examples figs. 82 and 83, plate XX.)

Summary

The Ookiep ores are of importance in establishing the type of magmatic copper deposits. All who have studied these ores have classified them as magmatic ores, but in spite of this they have received scant attention by the authors of textbooks and treatises on ore deposits. The principal reason for the failure to give these deposits full standing in the magmatic class is the presence of bornite. The Ookiep ores are magmatic, if such exist. They are the least altered of any we have examined in this study. The ore-bearing (chalcopyrite-bornite) norite from the Tweefontein mine is much freer from alteration than the average igneous rock. It is true that the mica diorite and hypersthenite at Ookiep locally show some alteration, but the significant thing is that the ore-minerals in the altered and unaltered rocks show exactly the same relation to the silicate minerals.

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ENGELS MINE, PLUMAS COUNTY, CALIFORNIA

Geology

A rather unique copper deposit, which we believe to be magmatic, is now being mined by the Engels Copper Mining Company in the northern part of Plumas county, California. This deposit has been studied and described by Turner and Rogers.[83]

The ore occurs in a remarkably fresh norite-diorite occurring at the extreme northern end of the great Sierra Nevada batholith of granodiorite. There is no evidence of dynamic metamorphism and none of contact metamorphism, for the older rocks into which the norite-diorite is intrusive are nearly five miles distant. The main ore body is a tabular ore shoot which has a nearly vertical attitude. It is difficult to see how this ore body could possibly be explained by gravitative adjustment due to the sinking of sulfids in the molten magma. Narrow pegmatite dikes are occasionally found cutting the norite-diorite.

Microscopic Descriptions

The predominant igneous rock at the Engels mine is a norite-diorite with about 46 per cent of silica. The principal minerals are plagioclase (andesine-labradorite, Ab_1 An_1), hypersthene, diopside, hornblende, and biotite. The norite-diorite varies from a rather fine-grained hypersthene-plagioclase rock to a coarse-grained hornblende-plagioclase rock. One of the typical fine-grained rocks (from no. 2 level) is illustrated in fig. 72. The opaque minerals here are magnetite and hematite. They surround and replace the silicates, especially hypersthene and biotite. Evidence of replacement is shown at many spots in the photomicrograph. A magnified view of one of these is shown in fig. 74. The magnetite and hematite have surrounded hypersthene and plagioclase, and have penetrated and replaced a biotite crystal. It will be noticed in fig. 72 that the magnetite occurs in both euhedral and anhedral crystals. The euhedral crystals occur within the silicate minerals, and the anhedral crystals mainly along the boundaries of adjacent silicate anhedra. This is also well shown in fig. 73. In this figure there is a magnetite crystal which shows anhedral development on the boundary between the hypersthene and plagioclase, and euhedral development within the hypersthene. This is an argument in favor of the late magmatic origin of

[83] A geologic and microscopic study of a magmatic copper sulphide deposit in Plumas county, California, and its modification by ascending secondary enrichment. Econ. Geol., **9**, 359-391 (1914).

euhedral magnetite, as is also the fact that all gradations between anhedral and euhedral forms occur. This practically proves that the euhedral, as well as the anhedral, magnetite is formed by the replacement of the silicates at a late stage. This rock is practically free from alteration.

The coarse-grained norite-diorite usually contains hornblende instead of hypersthene. The hornblende in these rocks has probably been formed from pyroxene. Evidence of this late magmatic alteration is furnished in fig. 75, where residual cores of diopside and hypersthene occur within a hornblende crystal.

In plate XIX are shown photomicrographs of a specimen somewhat similar to the rock just described, except that it contains alteration products. The ferro-magnesian minerals are hypersthene, diopside, and hornblende. The latter occurs as rims around the diopside (fig. 76).

The ore-minerals in this specimen are magnetite, hematite, chalcopyrite, and bornite. The magnetite contains regularly arranged ilmenite plates. The hypersthene is extensively altered to a mineral with indefinite aggregate structure. This contains tremolite and probably talc, and it is possible that tremolite is an intermediate product of the alteration of hypersthene to talc. Chlorite, another alteration product, occurs in veinlets which definitely cut the ore-minerals as shown in fig. 77.

Covellite and chalcopyrite of the second generation have been formed in occasional spots at the expense of the bornite (fig. 81). These are the result of the rearrangement brought about subsequent to the magmatic stage.

Some of the ore at the Engels mine occurs in a rather fine-grained felsic rock containing plagioclase, orthoclase (or microcline), quartz, and biotite, with minor accessories. For convenience this rock is called grano-diorite. In one specimen of this type apatite, titanite, epidote, calcite, and analcite were found. These are not alteration products of any minerals present in the rock, and are considered to be of late magmatic origin and formed by mineralizers. This rock is remarkably fresh; the only hydrothermal products present are a little chlorite formed from biotite and a little sericite from feldspar.

Another type of the fine-grained grano-diorite is exceptional in that it contains tourmaline. This specimen, which is figured in plate XIX (figs. 78 and 79), contains a good deal of bornite and chalcocite. The bornite occurs in irregular anhedra which surround and replace the silicates. The tourmaline has also been replaced by bornite (fig. 78). This specimen contains considerable chlorite, which is evidently pseudomorphous after biotite.

The igneous rocks which constitute the ores at the Engels mine contain varying amounts of alteration products, which are largely sericite, chlorite, tremolite, and talc. Some specimens, such as those represented by fig. 72, are practically free from alteration, while others are considerably altered. The hypersthene is frequently altered to a gray indefinite substance with aggregate structure (fig. 77). This is probably talc. It is probable that tremolite is an alteration product, intermediate in point of time between hypersthene and talc.

Sericite is present in certain specimens in fair amounts. It occurs as a replacement of feldspar, and also as a replacement of the sulfids. This is shown in fig. 78. The sharp lath-shaped crystals show well in contrast with the black bornite (and chalcocite), but exactly the same kind of crystals appears in the feldspars.

The chlorite occurs in definite veinlets cutting the ore-minerals (fig. 77), and also in lath-shaped sections resembling sericite and these also cut the ore-minerals (fig. 82).

The rearrangement of the ore-minerals in magmatic sulfid deposits is insisted upon by several writers to explain certain features. In the Engels ore the rearrangements brought about by lowering the temperature are well illustrated. The magnetite and hematite suffer no changes, but the bornite is often broken down into chalcocite, covellite, and chalcopyrite of the second generation. Examples of these are shown in plate XX. The so-called graphic intergrowth of bornite and chalcocite (fig. 80), as one of us suggests in a recent paper,[84] is a local, very irregular, replacement of bornite by chalcocite. The replacement of bornite by chalcocite also takes place in veinlets (fig. 83), and occasionally along crystallographic directions; but the best example of crystallographic influence during replacement is the break-down of the bornite to chalcopyrite of the second generation (fig. 81). Covellite also replaces bornite in irregular splotches (fig. 81), or along crystallographic directions (faintly shown in fig. 82).

It seems probable, as one of us[85] has stated, that a first generation of chalcocite (fig. 82) was formed before the sericite and chlorite, and a second generation (fig. 83) after sericite and chlorite. The former is hypogene,[86] the latter supergene.

[84] Rogers, A. F.—The so-called graphic intergrowth of bornite and chalcocite. Econ. Geol., 11, 582-593 (1916).

[85] Rogers, A. F.—Sericite a low-temperature hydrothermal mineral. Econ. Geol., 11, 118-150 (1916).

[86] Ransome, F. L.—Copper deposits near Superior, Arizona. Bull. 540, U. S. Geol. Surv., 152 (1912).

Summary

The Engels mine, which is rapidly becoming one of the important copper mines of California, is unique in that magmatic bornite is the principal ore-mineral. The ore occurs as a vertical ore shoot, and in a massive norite-diorite, in such relation to the enclosing rock that only a magmatic origin seems probable. Bornite and associated chalcopyrite are formed by mineralizers at a late magmatic stage, and not by hydrothermal solutions. This is proved by the comparative freedom from alteration in many of the ores and associated rocks. The silicification accompanying hydrothermal deposits generally is practically absent. Locally there may be sericitization and chloritization, but the bornite and chalcopyrite are no more abundant in the ores thus affected than in the unaltered ores. The secondary copper minerals, covellite, chalcocite, and chalcopyrite of the second generation, have developed at a later stage, in part by hypogene and in part by supergene solutions.

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REMARKS ON CERTAIN OTHER DEPOSITS THAT HAVE BEEN CLASSIFIED AS MAGMATIC

Pyritic Deposits

Beyschlag, Krusch, and Vogt[87] classify certain pyrite ores as magmatic ores under the heading "Die intrusiven Kieslagerstätten." Among these they place the Rio Tinto, Bodenmais, Sain Bel and Chessy, Agordo, and numerous Norwegian deposits. It is certain that some of these pyritic ores are hydrothermal in origin. The Rio Tinto deposits, for example, are due to metasomatic replacement of crushed and sheared zones by hydrothermal solutions, as was definitely proved by Finlayson.[88] The Rio Tinto and other pyritic deposits, such as the Rammelsberg, are placed by Lindgren[89] in his division "Deposits formed at Intermediate Depths." Lindgren, however, recognizes that some of the pyritic deposits may be due to the injection of molten sulfids.

The so-called intrusive or injected pyritic ores occur for the most part in gneisses. Igneous rocks are often closely associated, tho not always. The igneous rocks, however, are altered rocks, such as saussurite-gabbro. The ore-minerals are associated with typical metamorphic minerals such as cordierite, andalusite, anthophyllite, and chloritoid.

As these ores occur in areas of regional metamorphism, and are usually found in gneisses, schists, and not often in the igneous rocks themselves, it is difficult to see why they are placed with the magmatic ores. It seems far more reasonable to classify them as metamorphic ores, as Berg[90] does. We have not had an opportunity of examining many of these ores, but certain facts derived from our study of the undoubted magmatic ores leads to the conclusion that these are not of this type, or at least that the burden of proof rests upon any one who classifies them as such.

In the first place, we seriously doubt whether pyrite is a characteristic magmatic mineral. In our present study we have not found pyrite in any of the typical disseminated magmatic ores, and our speci-

[87] Loc. cit., 1, 298 (1910).

Ore Deposits. English translation by Truscott, 1, 301 (1914).

[88] Finlayson, A. M.—The pyritic deposits of Huelva, Spain. Econ. Geol., 5, 357-372, 403-437 (1910).

[89] Mineral Deposits, 602 et seq. (1913).

[90] Loc. cit., 114.

mens include representative suites of most of the important deposits except those from Norway. It is true that pyrite occurs in some of the Sudbury mines; we have examined several of these occurrences, and have found the pyrite to be distinctly later than the nickel-copper sulfids.

Later mineralization seems to be more prominent at the Worthington mine than at any other locality in the Sudbury district. Walker[91] says: "It is difficult to avoid the conclusion that the ores as they are now found at the Worthington mine have been subject to rearrangement by aqueous agencies since the solidification of the rock and sulfids from the original magma." Pyrite is evidently not a typical mineral at Sudbury. Browne,[92] for example, says: "Practically speaking, there is no pyrite, marcasite, or any other sulphide (he has previously mentioned pyrrhotite, chalcopyrite, and pentlandite) found in the great ore bodies."

Pyrite is entirely absent in the ores from the Engels mine. This might be attributed to lack of sufficient iron to combine with sulfur; but in the Namaqualand ores there was sufficient iron to form pyrrhotite, yet pyrite is entirely absent.

As a matter of fact, pyrrhotite seems to take the place of pyrite in the magmatic ores. The work carried on[93] at the Geophysical Laboratory, proving that pyrrhotite is the iron sulfid stable at high temperature, may explain this. Pyrite has usually been considered a persistent mineral.[94] Its maximum development, however, is reached in hydrothermal deposits, and it is less important in contact deposits and in those formed at low temperatures by meteoric water. True, pyrite is common in igneous rocks; but in the great majority of cases it has been introduced by hydrothermal solutions. There are a few authentic cases[95] of pyrite in fresh unaltered igneous rocks, and so its occurrence as a magmatic mineral can not be absolutely denied; but it seems certain that it is of minor importance as a magmatic mineral.

[91] Walker, T. L.—Certain mineral occurrences in the Worthington mine, Sudbury, Ontario, and their significance. Econ. Geol., **10**, 542 (1915).

[92] Browne, D. H.—Notes on the origin of the Sudbury ores. Econ. Geol., **7**, 468 (1906).

[93] Allen, E. T., Crenshaw, J. L., and Johnston, J.—The mineral sulphides of iron. Am. Jour. Sci. (4), **33**, 169-236 (1912).

[94] Lindgren, W.—The relation of ore-deposition to physical conditions. Econ. Geol., **2**, (1907).

[95] Lindgren, W.—The gold-quartz veins of Nevada City and Grass Valley districts, California. 17th Ann. Rept. U. S. Geol. Surv., pt. II, 66 (1896).

Spurr, J. E., and Garrey, G. H.—Prof. Paper no. 63, U. S. Geol. Surv., 388 (1908).

Magnetite-Ilmenite Deposits

Geologists apparently find little difficulty in accepting the titaniferous magnetites as magmatic deposits, probably because magnetite is a common accessory mineral of igneous rocks, but appear to be more cautious in regard to the sulfid deposits. We have examined a number of examples of the magmatic iron ores in "basic" rocks, and find that the relations of the ores to silicates are similar in all respects to those of the sulfid deposits. In the latter the sulfids may fail locally and the ores become identical with the low-grade titaniferous iron ores. The sulfid rich and sulfid free magnetite deposits alike develop subhedral crystals within the silicates; and the larger anhedral crystals cut, surround, and replace the silicates. They are often unaccompanied by secondary alteration products, and where these are present, they are later than the ores.

In order to check our incomplete study, we have examined the literature of these deposits, and find, contrary to the general impression, that the majority of those who have made a careful microscopic study of the ores conclude that they are later than the silicates. As a result of a similar review of the literature, Lindgren [96] states: "In these differentiated magmas ilmenite and magnetite have, as a rule, crystallized after the silicates." Berg [97] notes: "Die grosseren Erzmassen sind stets Anhaufungen des jungeren Erzes, umschliessen also einzelne Krystalle von Hypersthen, Diallag, Olivin, und Feldspat."

Other Magmatic Iron Ores

It is not our purpose to take up the remaining types of iron ores for which a magmatic origin has been suggested, the origin of some of which is obscure on account of the metamorphism they have undergone. In general, those deposits related to the less "basic" rocks, such as the Kiirunavaara type,[98] and certain of the Adirondack ores,[99] show evidence of increasing activity of mineralizers, with the occasional development of pneumatolytic and allied minerals, and a tendency to migrate further out from the mother rock.

In general, iron oxids, like the magmatic sulfids, appear to be concentrated, not during the early magmatic stages, but during the later stages and under the influence of mineralizers.

[96] Mineral Deposits, 749. [97] Loc. cit., 102.

[98] Igneous rocks and iron ores of Kiirunavaara, Luossavaara, and Tuollavaara. Econ. Geol., 5, 696-718 (1910).

[99] Newland, D. H.—On the association and origin of the non-titaniferous magnetites in the Adirondack region, 2, 763-773 (1907).

Chromite Deposits

Of the remaining ore-minerals concentrated as magmatic segregations, nickel-iron, gold, and platinum, do not occur in sufficient amounts to be considered as ores.

Chromite in unaltered rock from Norway, has been described by Vogt,[100] and is considered by him to be the oldest mineral of the rock, on account of its occurrence as sharp octahedra. Examination of his figures shows irregular as well as euhedral forms; and the alternate hypothesis that the chromite octahedra are formed at a late stage, is worthy of consideration.

Vogt states: "The chromite deposits in peridotite show accordingly the same geological, petrographical and morphological characteristics as those of titaniferous iron in gabbro, and the general genetic statements afterwards enumerated in connection with the titaniferous iron deposits hold good also for the occurrence of chromite." [101]

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[100] Beiträge zur genetischen Classification der durch magmatische Differentiationsprocesse und durch Pneumatolyse entstanden Erzvorkommen. Zeit. f. prakt. Geol., Jahrg. 1894, pp. 384-393.

[101] Ore Deposits: Beyschlag, Vogt, and Krusch; Translated by Truscott, (1914), 246.

PART III.
SUMMARY AND CONCLUSIONS

CRITERIA FOR THE RECOGNITION OF MAGMATIC ORES

Any discussion of the criteria by which the magmatic ores may be separated from other types of ores must be somewhat tentative in nature, as long as the latter have not received detailed comparative study.

The fact that the ores migrate only a short distance, if at all, into the adjoining rock, distinguishes them from contact deposits formed chiefly in the intruded rock, and from many other high-temperature deposits.

Comparison, then, must be made with ores that occur in, and as an integral part of, igneous rocks.

The fact that the only high-temperature alteration mineral present in appreciable amount is hornblende, which we believe is formed by magmatic processes, and that tourmaline and garnet are only occasionally developed, distinguishes these deposits from those in which destructive pneumatolytic and contact action is prominent.

The fact that hydrothermal alteration of the silicates is often minor in amount, is invariably later than the ores, and generally is not accompanied by the deposition or migration of ores, differentiates these ores from those of hydrothermal origin.

The absence of silicification and albitization, and the only occasional development of considerable amounts of sericite, separate these deposits from moderate- and high-temperature ores in igneous rocks, such as the copper ores of Bingham and Butte and the gold ores at Treadwell, Alaska, etc.

There is definite order of succession of the magmatic ore-minerals, as follows: magnetite, hematite, pyrrhotite, pentlandite, chalcopyrite, bornite. Any change in this order is due to rearrangement subsequent to the magmatic period.

Pyrite is not a typical magmatic mineral; if present in a magmatic ore, it is introduced later than the magmatic period.

SUMMARY OF THE CHARACTERISTICS OF MAGMATIC ORES

Contrary to general opinion, the magmatic sulfids are formed by replacement of the silicates after the solidification of the igneous rock. Notwithstanding this, we retain the term "magmatic ore deposits" for the types of ores described in this paper, because they have a close genetic relation to the intrusive rock in which they occur, and because they are formed within the magmatic stage as defined by us. Regardless of any theory as to their genesis, however, these deposits have definite and easily recognizable characteristics, which distinguish them from all other types of ore deposits.

The characteristics of the magmatic sulfid ores as brought out by our study may be summarized as follows:

(1) They occur in subsilicic rocks of the norite, gabbro, peridotite, or related families.

(2) In most occurrences the containing rock is either dominantly subsilicic, with minor amounts of complementary persilicic differentiates (Insizwa), or occurs as lenses of mafic rock in a large granitic intrusion (Golden Curry).

(3) The subsilicic rock occurs generally as small dikes, sills, or stocks, and rarely as a large laccolith (Sudbury).

(4) In most cases the ore-bearing rock has undergone marked differentiation, and the differentiated portions are sharply separated and do not grade into each other (Ookiep).

(5) The ore may occur in any variety of rock produced by differentiation, but in any one locality the ore shows marked preference for certain types of rock and occurs sparingly in others (Ookiep).

(6) Pegmatite and aplite dikes often cut, and are therefore later than, the ore bodies (Erteli).

(7) The ore is generally segregated at the margins of the intrusives, but occasionally occurs as lenses or tabular ore shoots well within the intrusive magma (Engels). In sills, the ore is usually at the base of the intrusives (Insizwa); in dikes, it often is formed along the footwall (Sohland), or as columnar or irregular shoots occupying the entire width of the dike (Copper Cliff).

(8) Very often the ore is concentrated in those portions of the intrusive which have suffered brecciation during intrusion (Sudbury).

(9) The ore migrates only a short distance into the adjacent rock, from a few inches to a few score of feet at most (Sudbury).

(10) The "offset" deposits, formed in dikes at some distance from the main intrusive, are accompanied and cut by veins carrying ore and gangue minerals of hydrothermal origin (Sudbury).

(11) There is no essential distinction between the sulfid group and the magnetite-ilmenite group as to the origin or the relation of the ores to the silicate minerals. In all the magmatic ores examined, ore deposition takes place at the close of the magmatic period.

(12) There are two general classes of the magmatic sulfid ores: (*a*) pyrrhotite-chalcopyrite deposits, and (*b*) chalcopyrite-bornite deposits.

(13) The so-called pyritic intrusive ores are not magmatic.

(14) The principal ore-minerals of the magmatic period include magnetite, ilmenite, hematite, pyrrhotite, pentlandite, chalcopyrite, and bornite

(15) Pyrrhotite and bornite have not been found together in magmatic ores.

(16) Pyrite is not a typical magmatic mineral.

(17) The ore-minerals are formed at a late magmatic stage by a partial replacement of the silicate minerals. The ores surround, embay, and cut all the earlier silicates. They penetrate the cleavable minerals. They occasionally occur as sharp veinlets which lead out from the larger sulfid masses. Selective replacement is shown by the preservation in the ores of an original graphic texture of the rock.

(18) There is a definite order of formation of the principal magmatic ore-minerals. This order is as follows: magnetite-ilmenite (intergrowth), hematite, pyrrhotite, pentlandite, chalcopyrite, and bornite.

(19) There is evidence of the replacement of one magmatic ore-mineral by another.

(20) Euhedral magnetite and probably other minor accessories occurring in euhedral crystals, such as apatite, zircon, titanite, etc., are also formed at a late magmatic stage.

(21) There is clear evidence of the magmatic alteration of pyroxene to hornblende prior to the introduction of the ore-minerals.

(22) Hydrothermal alteration, altho seldom lacking in magmatic ores, is relatively insignificant, and is distinctly later than the magmatic ore period. The silicates of the hydrothermal period include tremolite, anthophyllite, sericite, chlorite, and serpentine. These secondary silicates often replace the magmatic ore-minerals in veinlets and in sharp

lath-shaped crystals without causing any change or migration of the ore-minerals.

(23) The attention given these alteration products in order to determine their relative age, may have given an erroneous impression as to their relative abundance. In most of the ores studied they are present only in minor amounts. Many of the magmatic ores are as free from alteration products as the average unmineralized igneous rock.

(24) However, a minor amount of rearrangement, consisting in the production of microscopic crystals of pentlandite and chalcopyrite of the second generation, has been detected in the pyrrhotitic ores. In the chalcopyrite-bornite ores there has been some migration, resulting in the formation of minor amounts of covellite, chalcocite, and chalcopyrite of the second generation. This alteration is only prominent where there has been an abnormal development of sericitization.

(25) The rôle of mineralizers in magmatic differentiation has not been sufficiently emphasized. The crystallization of the early formed minerals in the magma involves the complementary process of the "squeezing out" of the residual fluid. This process is not merely a mechanical one, but is also due to gaseous extraction.

(26) The typical magmatic deposits, unaccompanied by high-temperature alteration, with the exception of magmatic hornblende, are chiefly developed in "basic" rocks. Ore deposits genetically related to persilicic rocks show intense rock alteration, probably the result of mineralizers more "active" than those accompanying the subsilicic rocks.

(27) There is a parallelism between the various groups of high-temperature deposits, of which the magmatic ores are one division. In all groups, high-temperature silicates precede the introduction of the ore, and hydrothermal stages follow. In contrast with the magmatic deposits, the non-magmatic ores are characterized by a complex set of pre-mineral silicates, and the hydrothermal stage is generally the most important period of ore introduction.

(28) The temperature at which the introduction of ore-minerals is initiated is about the same for all the high-temperature deposits; probably not higher than 300-400° C.

(29) Gradations between the typical magmatic ores and other high-temperature deposits are shown by the local development of garnet and tourmaline. Further, the gradations of these into intermediate-temperature and low-temperature deposits is strong evidence of the magmatic origin of ore deposits in general.

(30) The following orderly series of events is recognized in magmatic deposits:

(*a*) Crystallization of primary silicates;

(*b*) The development of hornblende and biotite, and occasionally tourmaline and garnet, as magmatic alteration products;

(*c*) The introduction of the ore-minerals;

(*d*) A small amount of rearrangement of the ores and the development of secondary silicates by hydrothermal solutions.

Department of Geology,
Leland Stanford Junior University,
October, 1916

EXPLANATION OF PLATES AND METHODS OF PREPARING PHOTOGRAPHS AND SECTIONS

The photographs are of two types: thin sections and polished sections. The thin sections are necessary for the identification of the silicates; the polished sections for the identification of the ore-minerals,

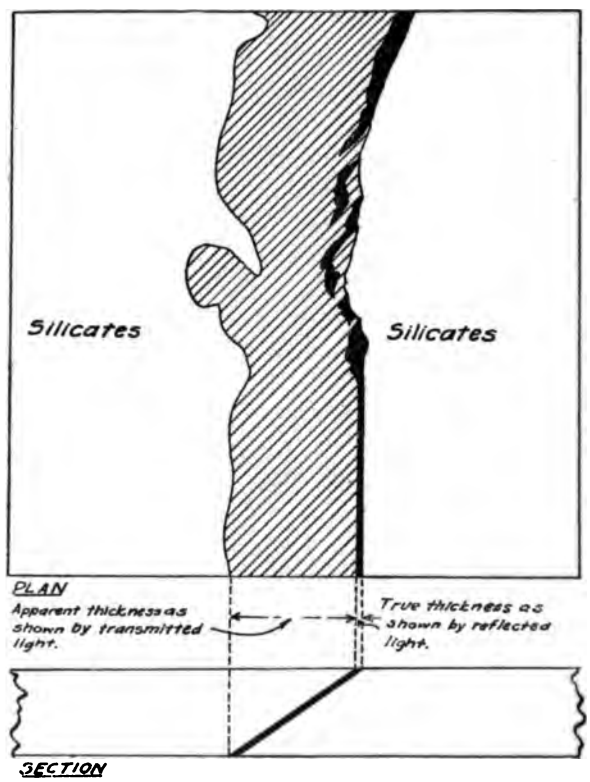

Fig. 6A. Drawn from a photograph of a polished thin section of ore from the Stobie mine, Sudbury. White areas are silicates. Lined area is opaque band as viewed by transmitted light. Black band is veinlet as shown by reflected light. (x 175)

and to show the relations of the various minerals to each other. In examining the photographs note that the ore-minerals are black and the silicates light in thin sections, while the silicates are dark gray and the ore-minerals white or light gray in the polished sections.

In taking the photographs we have used Wratten panchromatic plates, selecting in each case the color screen best adapted to bring out all the minerals in the polished section.

In the microscopic investigation we examined (1) thin sections with the polarizing microscope; (2) polished sections with the reflecting microscope; and (3) polished thin sections (combination sections) with both transmitted and reflected light.

It is now generally admitted that the examination and determination of the opaque minerals in thin sections is at best unsatisfactory, and that only the grosser relations of the opaque minerals to each other can be made out, and that those details requiring high magnifications are lost entirely.

In addition to the above, we have found that the relations of the opaque minerals, as a group, to the transparent minerals, are shown more accurately in polished surfaces than in thin sections, and that the relations of the transparent silicates to each other are sharper when viewed with the reflecting microscope than with the polarizing microscope, altho the identification of the transparent minerals must be made with the latter.

The reason for this is simple. In examining a thin section, one looks thru a certain thickness of rock, and not at a single definite surface. All contacts between the opaque and transparent minerals that are not perpendicular to the surface of the slide are widened so that the black area represents the projection on the surface of the section of all the opaque material contained in the slide. A thin section does not show, therefore, the relation of the opaque and the transparent minerals at one definite level as do the polished sections. Fig. 6*a*, page 74, was drawn from a photograph of a polished thin section viewed under both transmitted and reflected light. The ruled band represents the shadow cast by the opaque material as viewed with transmitted light, and the thin black line at the margin of the band shows the true thickness of the veinlet as registered by the light reflected from the polished surface.

In order to take advantage of the reflecting microscope for this work, it was necessary to develop special methods of polishing in order to give a satisfactory brilliant surface to the silicates as well as to the hard and soft opaque minerals. As a matter of fact, the polishing of all the different constituents in a single section of complex ore is an art, and, up to date, only crude methods of polishing have been described in the literature.

Our methods, in brief, consist in grinding on a glass plate a plane surface with the minimum of pits, using successively finer grades of carborundum, and then "sixty-minute" carborundum, and finally a still finer carborundum prepared in our laboratory.

The final polishing is done with fine cambric on rapidly rotating wheels (1700-3400 r.p.m.). Silicates, magnetite-ilmenite, pyrite, etc., are polished by carborundum, prepared by grinding the "sixty-minute" grade two weeks in a ball mill, and then floating off the finest product for this purpose. Chrome oxid is used to polish sulfids of average hardness, and aluminum oxid for the softer sulfids. These powders are applied one after the other, or as mixtures, depending upon the character of the specimen. To develop a polish of the highest brilliancy on the sulfids—for example to bring out pentlandite enclosed in pyrrhotite—aluminum oxid is used on the finest billiard felt.

In most cases we find it satisfactory to use one side of a sawed specimen for the polished section and the adjacent surface for the thin section. In some cases a thin section is given a high polish, which acts like a cover-glass in giving clear images with transmitted light, and also gives brilliant reflections with reflected light.

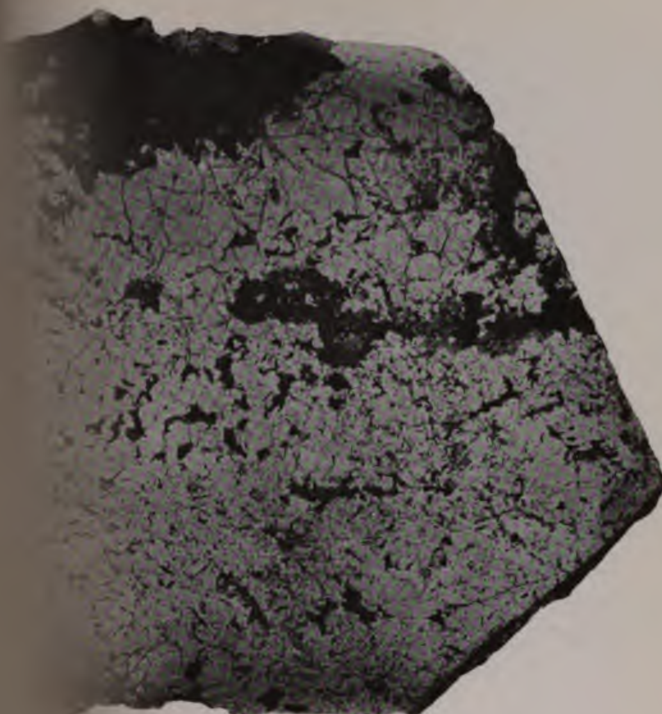

Fig. 7

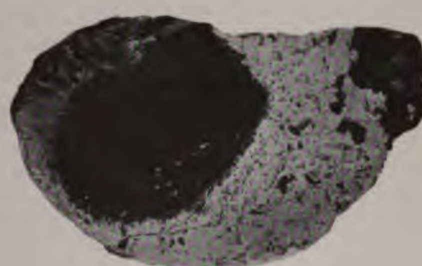

Fig. 9

Fig. 10

PLATE I

PHOTOGRAPHS OF POLISHED SPECIMENS OF SUDBURY ORES

FIG. 7

Rich ore (pyrrhotite and pentlandite) from Copper Cliff mine, showing unreplaced silicates [dark areas] of the granitic rock.
Nat. size

FIG. 8

Ore from the Creighton mine showing chalcopyrite veinlets.
x 1 2/3 diameters

FIG. 9

Nodule of "basic" material in granitic rock which has been largely replaced by pyrrhotite [light gray]. Creighton mine.
x 87/100

FIG. 10

Pyrrhotite [light gray] impregnating and replacing "greenstone schist." Garson mine.
x 8/10

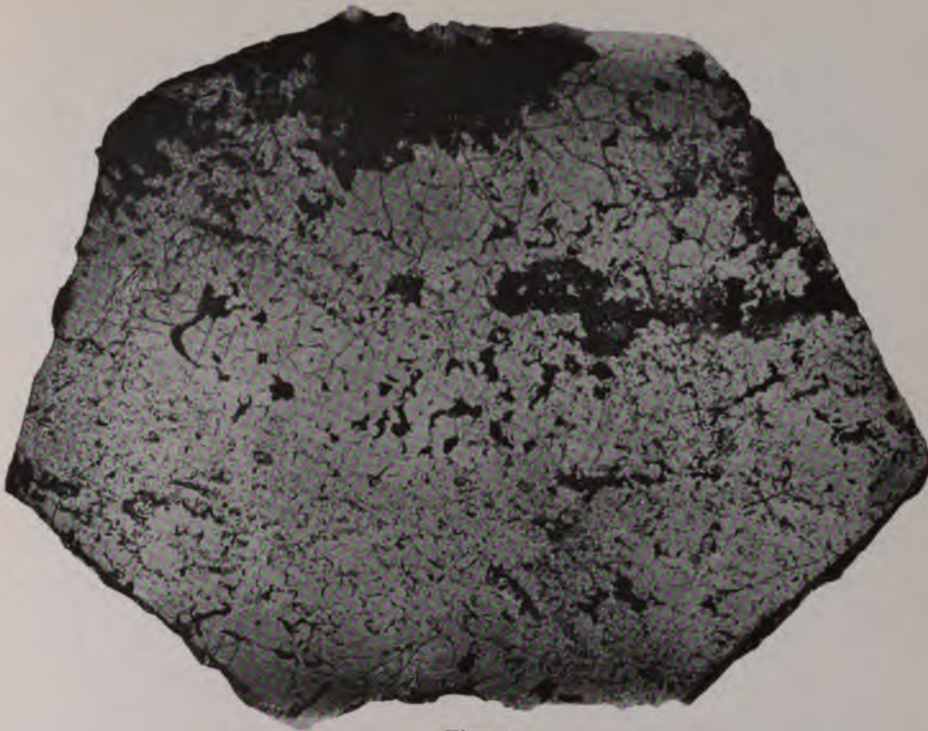
Fig. 7

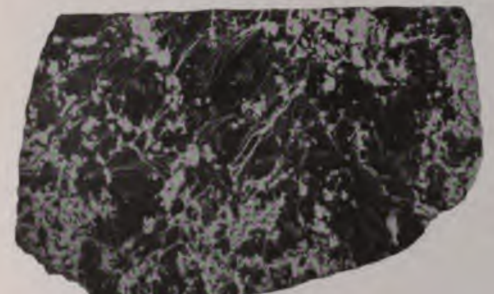
Fig. 8

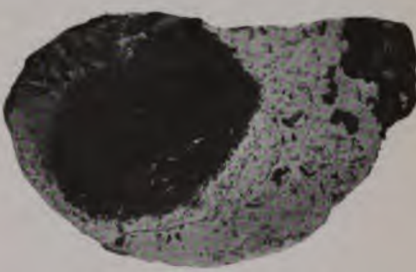
Fig. 9


Fig. 10

PLATE II

PHOTOMICROGRAPHS OF THIN SECTIONS OF LEAN ORE FROM THE STOBIE MINE, SUDBURY

FIG. 11

Typical norite with euhedral magnetite [black], hypersthene [gray], plagioclase [white].

Magnification x 36 diameters.

FIG. 12

Ore-minerals; magnetite, pyrrhotite [black], surrounding and replacing hypersthene [gray]. A veinlet of chlorite [*ch*] cuts magnetite. In the upper portion of the photograph the hypersthene is fresh, and in the lower part it is altered; and yet the ore shows the same relation to the silicates in the fresh and altered portions.

x 30

FIG. 13

A veinlet of chlorite [*ch*], cutting the sulfids, chalcopyrite and pyrrhotite [black], and the silicates.

x 36

FIG. 14

Tremolite [*tr*] crystals cutting—not residual in—chalcopyrite [black], and projecting from altered hypersthene [gray].

x 119

Fig. 11

Fig. 12

Fig. 13

Fig. 14

PLATE III

PHOTOMICROGRAPHS OF POLISHED SECTIONS OF ORES FROM THE STOBIE MINE, SUDBURY

FIG. 15

Lean ore. Chlorite veinlets cutting ore-minerals; magnetite, pyrrhotite, chalcopyrite [light], and the silicates.

x 11

FIG. 16

Plagioclase [dark], uralite [light gray], and sulfids [white]. Figs. 17 and 18 are higher magnifications from the same field.

x 10

FIG. 17

Veinlet and crystals of tremolite [gray] cutting pyrrhotite.

x 270

FIG. 18

Pyrrhotite [*p*] and pentlandite $[pn]_1$ cut by irregular veinlets of secondary silicates [*ss*]. A second generation of pentlandite (?) $[pn]_2$ grows out in tufts from these veinlets. The secondary migration of ore-minerals is therefore insignificant in amount.

Aggregates of tremolite crystals on the right of the photograph.

x 165

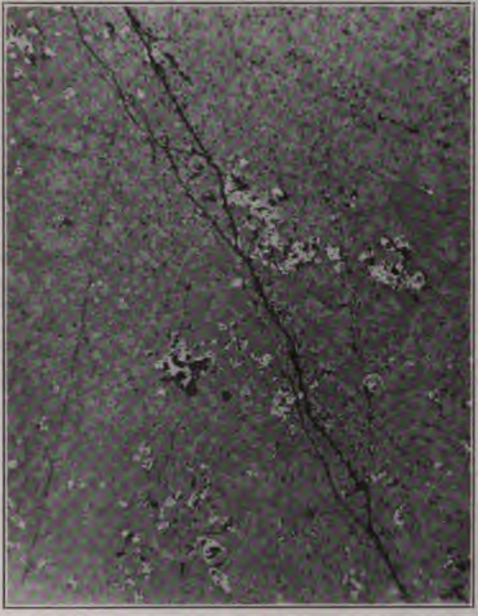

Fig. 15

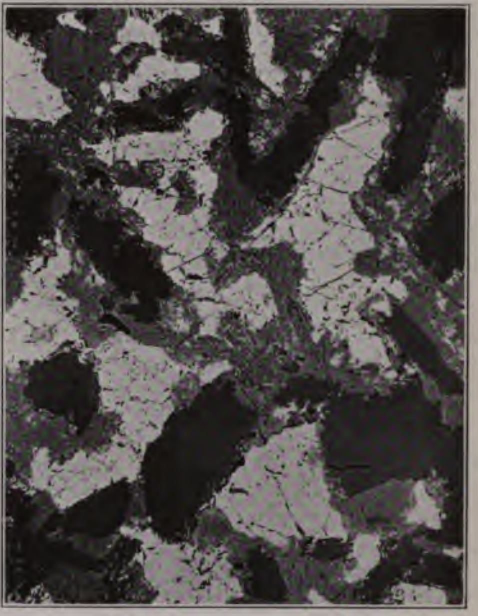

Fig. 16

Fig. 17

Fig. 18

PLATE IV

Photomicrographs of ores from Sudbury

Fig. 19

Polished section of rich ore from the Stobie mine. Irregular areas and veinlets of chalcopyrite [white] replacing garnet [*g*] and other silicates.

x 16

Fig. 20

Copper Cliff mine. Thin section of ore in coarse granitic material. Ore-minerals [black areas], magnetite and pyrrhotite, cutting and replacing biotite.

x 38

Fig. 21

Polished section, Creighton mine. Crystallographic intergrowth of magnetite and ilmenite [parallel dark lines]. Specimen is not etched, but contrast is brought out by high polish.

x 790

Fig. 22

Polished section, Creighton mine. Typical rich ore showing pyrrhotite [*p*] with veins of pentlandite [*pn*] and residual magnetite [*m*] and silicates [*s*].

x 14

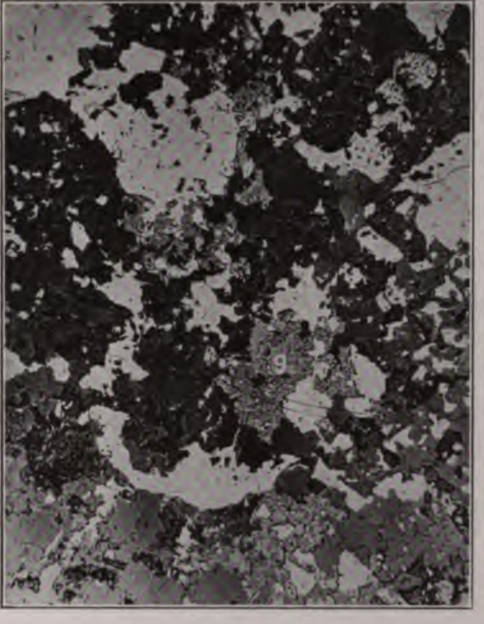

Fig. 19

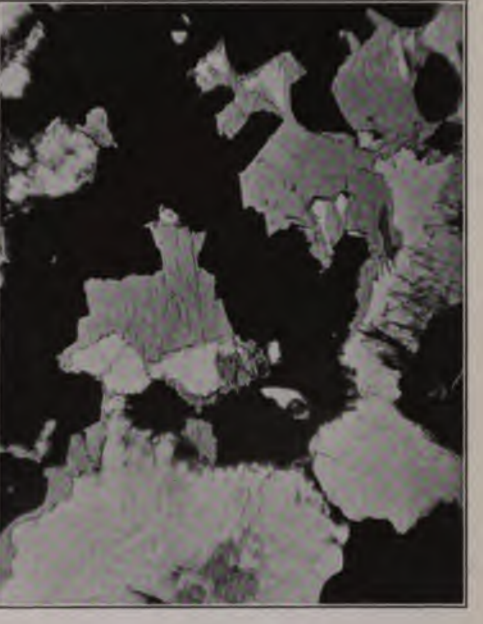

Fig. 20

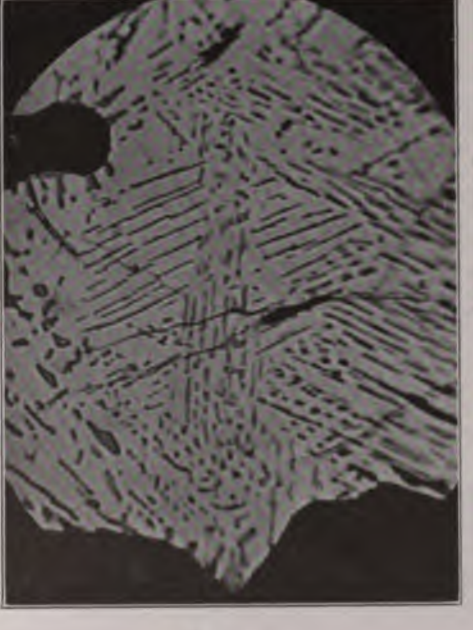

Fig. 21

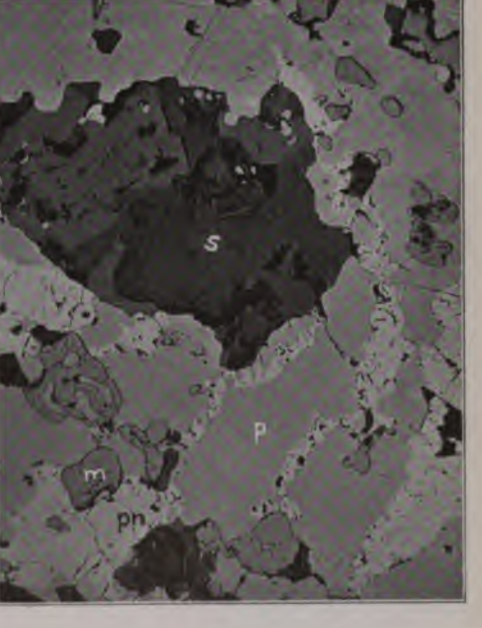

Fig. 22

PLATE V

PHOTOMICROGRAPHS OF THIN SECTIONS OF ORE FROM SUDBURY

FIG. 23

Ore from the Creighton mine. Large, irregular ore masses [black] are chalcopyrite and pyrrhotite. Small subhedral black spots are chalcopyrite, probably a replacement of magnetite, as they contain residual specks of the latter. Oreminerals cut through the silicates and replace them. Veinlets at the bottom of photograph are chalcopyrite.

x 28

FIG. 24

Creighton mine. Chalcopyrite veinlets [black] cut microcline, quartz, and biotite [dark gray], which are free from alteration products.

x 66

FIG. 25

Creighton mine. Sulfid veinlets, chalcopyrite and pyrrhotite, which extend out from a mass of sulfids [black], cut silicates [hornblende and plagioclase].

x 27

FIG. 26

Evans mine. Chalcopyrite veinlet cuts hornblende [*ho*], biotite [*bi*], and plagioclase [white]. Displacement, shown by hornblende crystal, has taken place along this veinlet. Beyond the field of the photograph chlorite cuts across the veinlet. [*ap*] apatite.

x 158

Fig. 23

Fig. 24

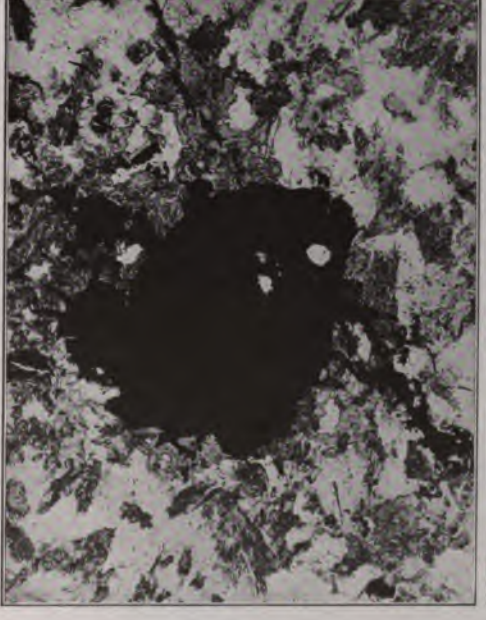

Fig. 25

Fig. 26

PLATE VI

PHOTOMICROGRAPHS OF POLISHED SECTIONS OF "ACID" ORE-BEARING ROCK FROM THE CREIGHTON MINE, SUDBURY

FIG. 27

Ore masses, pyrrhotite and chalcopyrite, extend out into fine veinlets, chiefly chalcopyrite. Large masses replace the silicates. The veinlets cut the subgraphic intergrowth of quartz [*q*] and feldspar [*f*]

x 10

FIG. 28

Sulfids, pyrrhotite [*p*] and chalcopyrite [*cp*] cut magnetite [*m*] and silicates in anastomosing veinlets.

x 15

FIG. 29

Chalcopyrite [*cp*] extending from the main mass into veinlets as one generation of ore. No evidence of "rearrangement" or second generation of ore in veinlets. A mass of pentlandite [*pn*] enclosed in chalcopyrite.

x 99

FIG. 30

Sharp veinlets of chalcopyrite cut the graphic intergrowth of quartz [dark] and feldspar [light].

x 260

Fig. 27

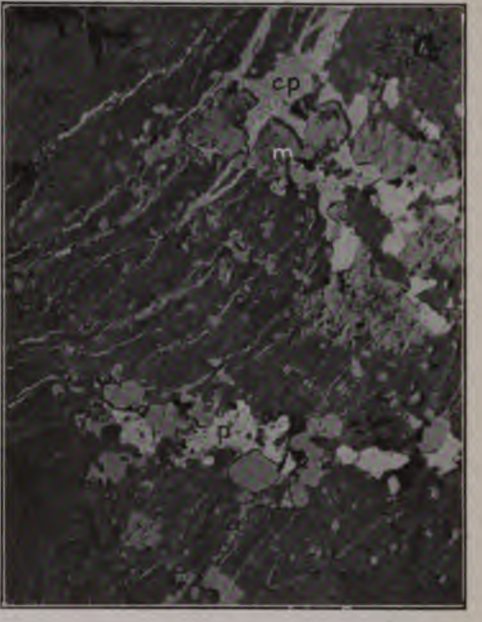

Fig. 28

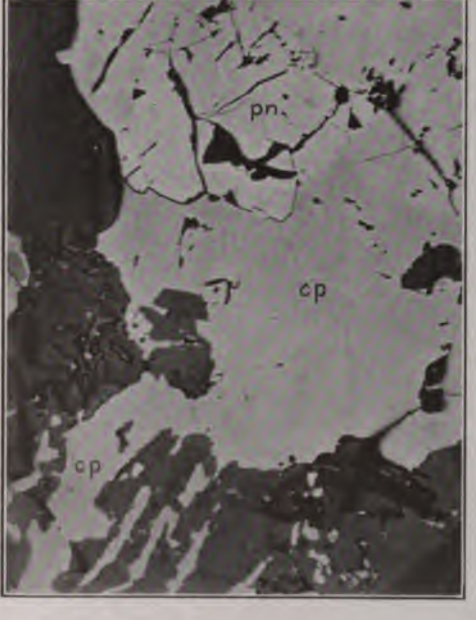

Fig. 29

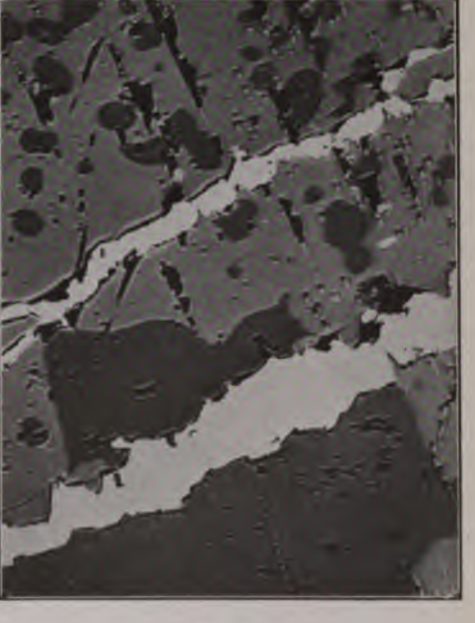

Fig. 30

PLATE VII

PHOTOMICROGRAPHS OF POLISHED SECTIONS OF "ACID" ORE-BEARING ROCK FROM THE CREIGHTON MINE, SUDBURY

FIG. 31

Selective replacement by sulfids [white] of feldspar [light gray] in the feldspar-quartz intergrowth. Quartz is dark gray.

x 18

FIG. 32

Sulfids, pyrrhotite [*p*] and chalcopyrite [*cp*] and veinlike masses of pentlandite [*pn*]. In the center of the field chalcopyrite preserves the structure of the graphic intergrowth by selective replacement of the feldspar.

x 18

FIG. 33

Graphic intergrowth of quartz and feldspar. A small irregular replacement veinlet cuts the fine graphic intergrowth above. Large-scale graphic intergrowth below preserved by selective replacement of feldspar by sulfids.

x 71

FIG. 34

An irregular area of magnetite replacing silicates.

x 140

Fig. 31

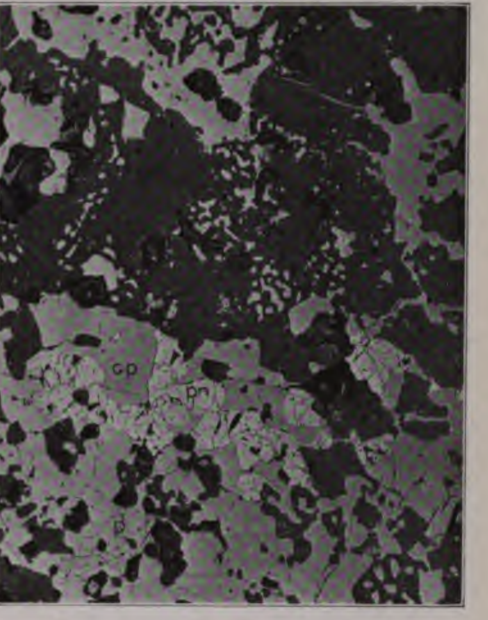

Fig. 32

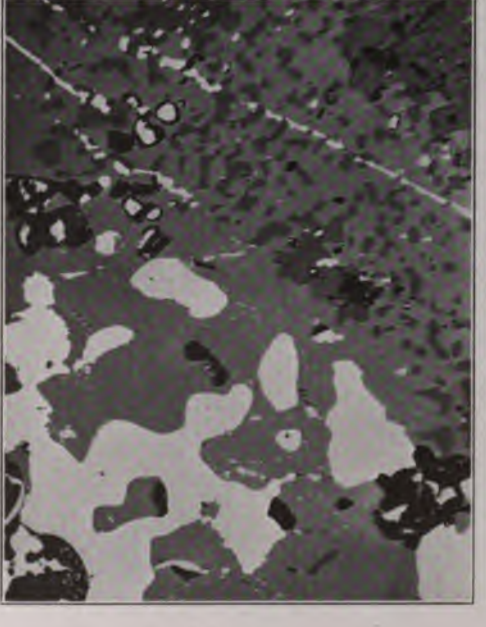

Fig. 33

Fig. 34

PLATE VIII

PHOTOMICROGRAPHS OF POLISHED SECTIONS OF ORES FROM SUDBURY

FIG. 35

Massive ore from the Creighton mine showing typical vein-like areas of pentlandite [*pn*]$_1$ in pyrrhotite [*p*]. Contrast brought out by polishing, not by etching. Tiny brush-like crystals of a second generation of pentlandite [*pn*]$_2$ develop along veinlets and contacts. See Fig. 36.

x 18

FIG. 36

Massive ore from the Creighton mine. Second generation of pentlandite [*pn*] along a veinlet of chalcopyrite [*cp*], cutting pyrrhotite [*p*]. This rearrangement of ore-minerals is minor in amount, and can rarely be noted even under high powers. (Same specimen as shown in Fig. 35.)

x 670

FIG. 37

Massive ore from the Vermilion mine, showing pyrite veinlets [dark gray] cutting polydymite (?) [*po*] and chalcopyrite [*cp*]. Note that pyrite is definitely later than the typical magmatic ore-minerals in all the occurrences figured.

x 10

FIG. 38

Ore from the Worthington mine. Pyrite [white] with a reticulate structure, cutting gangue [black] and sphalerite [gray].

x 58

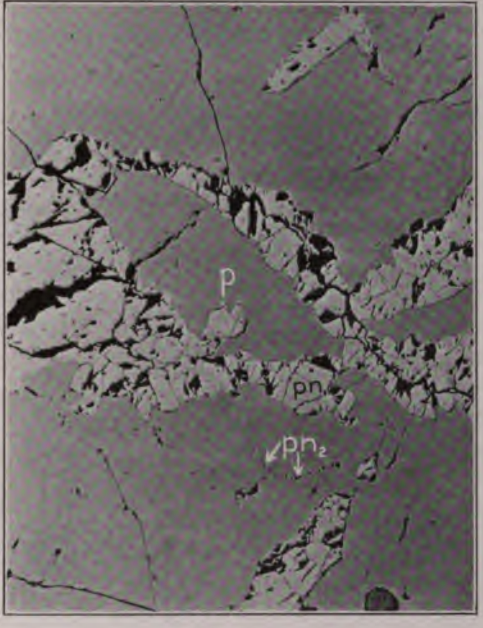

Fig. 35

Fig. 36

Fig. 37

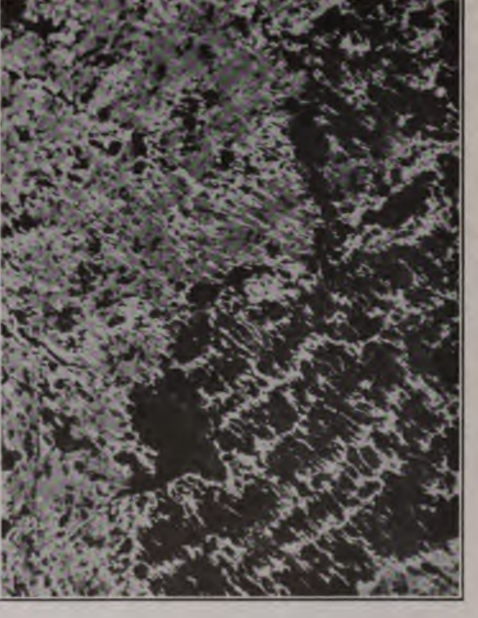

Fig. 38

PLATE IX

PHOTOMICROGRAPHS OF POLISHED SECTION OF ORE FROM THE ALEXO MINE, NORTHERN ONTARIO, CANADA

FIG. 39

Shows the general relations of the ore-minerals [large white areas] to the serpentinized silicates. The original ore-minerals, chiefly pyrrhotite and pentlandite with subordinate chalcopyrite and magnetite, surround and embay the serpentine pseudomorphs after olivine.

A minor amount of the second generation of chalcopyrite has been concentrated by serpentinization within the silicates.

x 17

FIG. 40

Enlargement of a part of the field in the upper left-hand portion of Fig. 39. Shows serpentine pseudomorphous after olivine, surrounded by magmatic sulfids, the contacts of which are not modified by serpentinization. The latter, however, affects a secondary concentration of chalcopyrite developed as a border between two different types of serpentine.

x 70

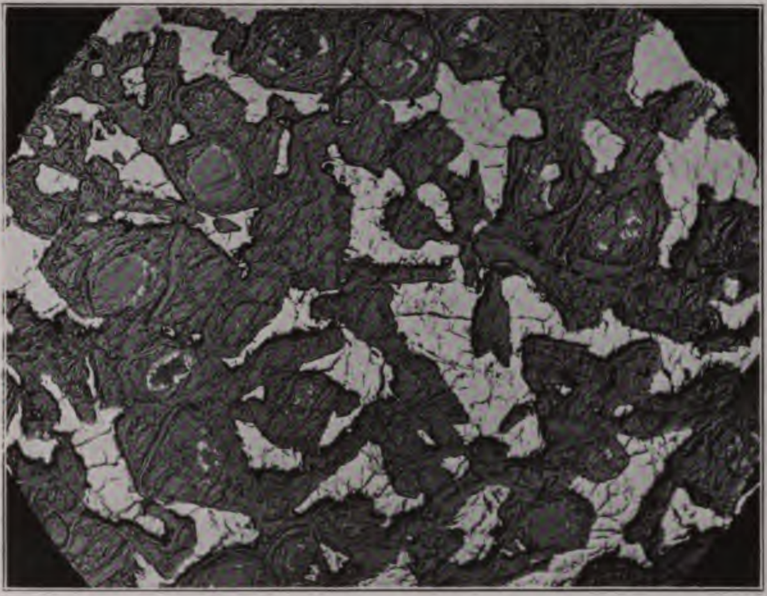

Fig. 39

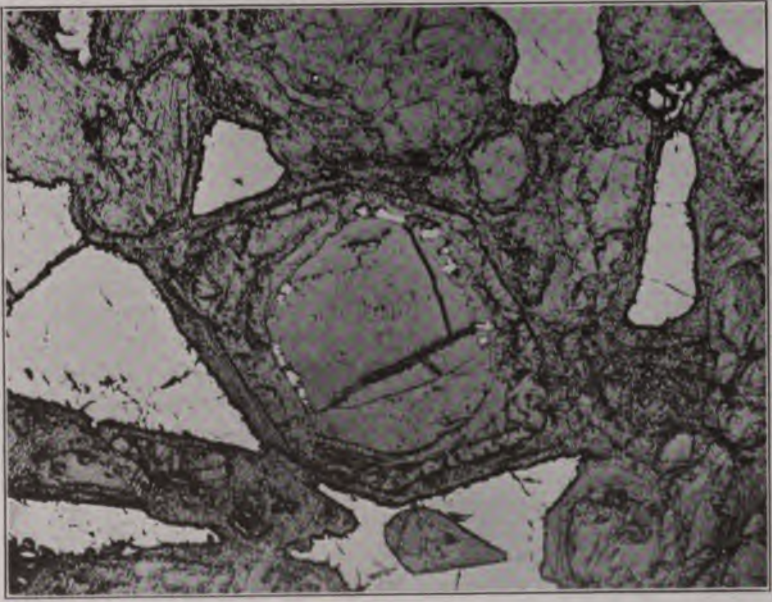

Fig. 40

PLATE X

PHOTOMICROGRAPHS OF ORE FROM THE ALEXO MINE, FROM THE SAME POLISHED SECTION FIGURED IN PLATE IX

FIG. 41

Pyrrhotite [*p*], pentlandite [*pn*], chalcopyrite $[cp]_1$, and magnetite [*m*] cut by veinlets of serpentine.

x 44

FIG. 42

First $[pn]_1$ and second $[pn]_2$ generations of pentlandite in pyrrhotite [*p*]. The two generations can be distinguished by a slight difference in relief and color. Serpentine veinlets are later than the first generation pentlandite and closely connected with the second generation. Pentlandite and serpentine tend to develop along the crystallographic lines of the pyrrhotite.

x 175

FIG. 43

Pyrrhotite [*p*] and pentlandite [*pn*] of the first generation, cut by a serpentine veinlet with a center of magnetite [*m*], along which pentlandite of the second generation $[pn]_2$ develops.

x 610

FIG. 44

Showing later generations of chalcopyrite $[cp]_2$ connected with different stages of serpentinization. A large mass of pyrrhotite [*p*] is shown near the top of the photograph. Small dots in center may be a third generation of chalcopyrite.

x 183

Fig. 41

Fig. 42

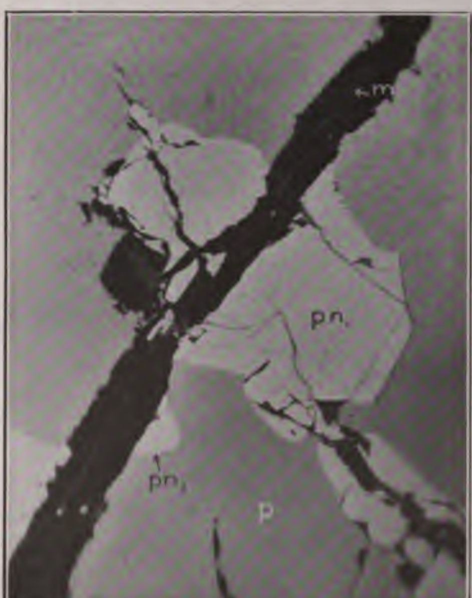

Fig. 43

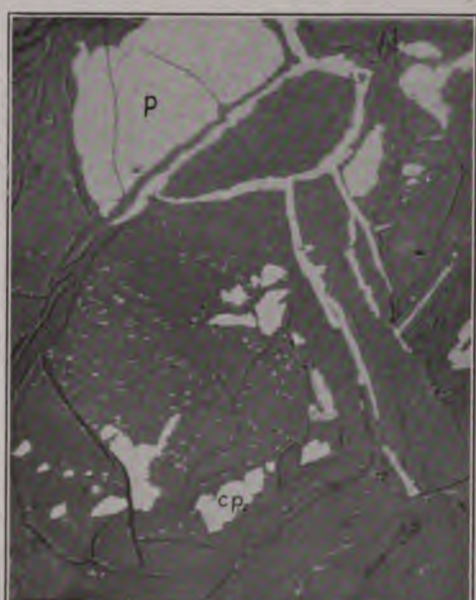

Fig. 44

PLATE XI

PHOTOMICROGRAPHS OF THIN SECTION OF PYRRHOTITE-BEARING PYROXENITE FROM THE GOLDEN CURRY MINE, ELKHORN, MONTANA

FIG. 45

Sulfids [black], chiefly pyrrhotite with some chalcopyrite, surrounding and penetrating augite. White needles in the sulfids in the center of photograph are tremolite and darker patches to the right are hornblende.

x 22

FIG. 46

Sulfids replacing hornblende along cleavages.

[The white streak (lower center) is a crack in the slide.]

x 130

FIG. 47

Sulfids surrounding and penetrating pyroxene. A hornblende crystal [*ho*] in the center is bordered by tremolite [*tr*] needles which cut the ore-minerals.

x 90

Fig. 45

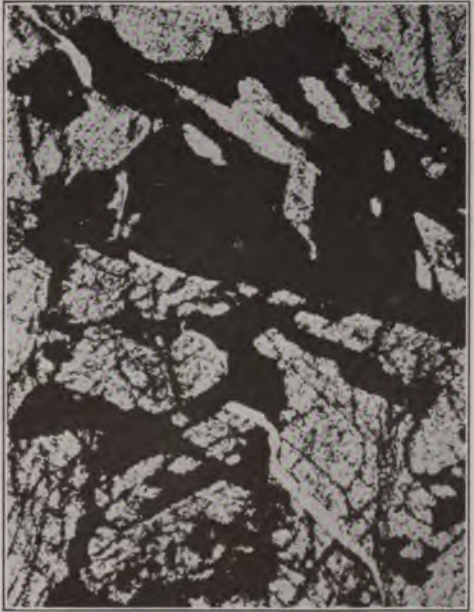

Fig. 46

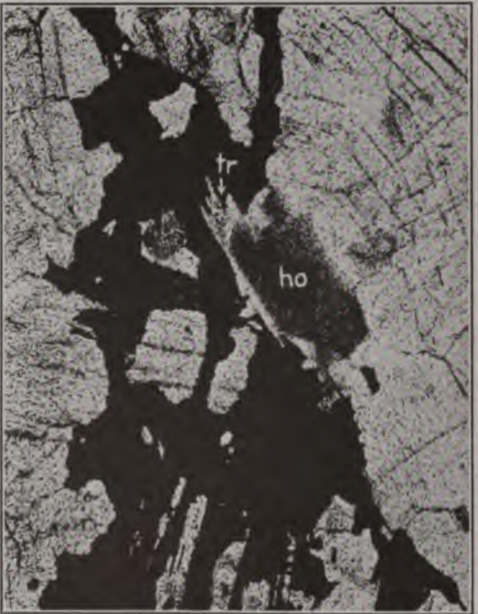

Fig. 47

PLATE XII

Photomicrographs of polished sections from Evje, Norway, and Sohland, Germany

Fig. 48

Ore from the Flaad mine, Evje, Norway.

Pyrite [*py*] veinlet and detached crystals in pyrrhotite [*p*] and magnetite [*m*]. The veinlet is connected with alteration products. See fig. 49 for the relation of pyrite crystals to pyrite veinlets.

x 12

Fig. 49

Ore from the Flaad mine, Evje, Norway.

Pyrrhotite [*p*] cut by chalcopyrite [*cp*] which in turn is cut by pyrite [*py*] veinlets. The latter connect with subhedral and euhedral crystals. The euhedral crystals are shown in fig. 48.

x 300

Fig. 50

Ore from Sohland, Saxony.

Shows general relations. The ore-minerals are pyrrhotite [*p*], chalcopyrite [*cp*], and pentlandite [*pn*]. Uralite needles [*u*] penetrate into the sulfids. Other silicates [*s*] are hornblende and alteration products. A good example of extensive post-mineral alteration.

x 12

Fig. 51

Ore from Sohland, Saxony.

Uralite [*u*] needles cutting pyrrhotite [*p*] and pentlandite [*pn*]. The uralite (or tremolite) develops at the ends of the hornblende crystals.

x 116

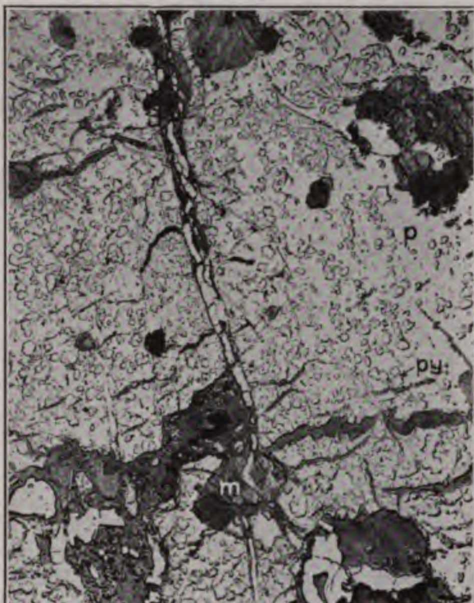

Fig. 48

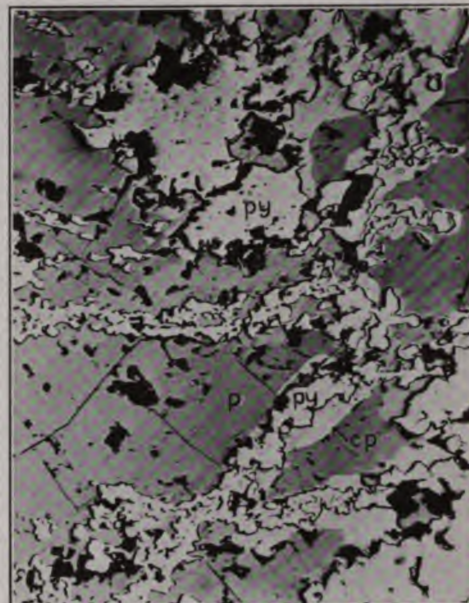

Fig. 49

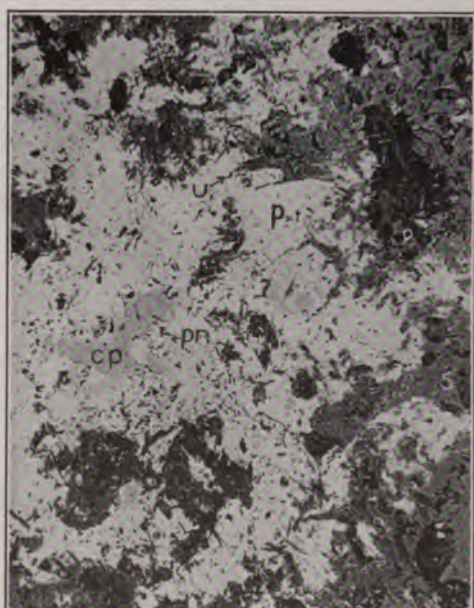

Fig. 50

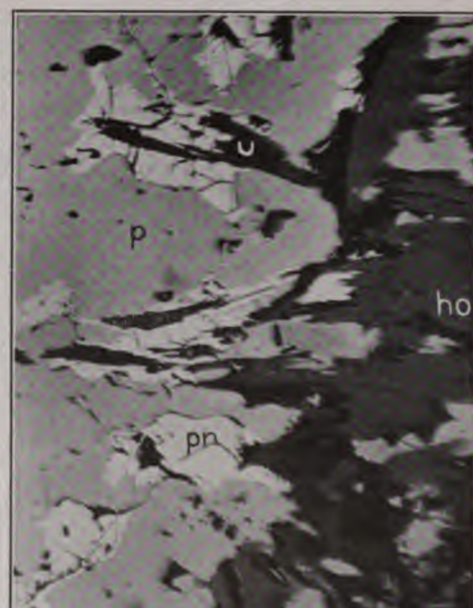

Fig. 51

PLATE XIII

PHOTOMICROGRAPHS OF SECTIONS OF ORE-BEARING HYPERSTHENITE FROM NABABEEP MINE, OOKIEP, SOUTH AFRICA

FIG. 52

Thin section showing ore-minerals [black], magnetite and a little bornite, cutting and surrounding hypersthene.

× 74

FIG. 53

Thin section of hypersthenite showing euhedral crystals of magnetite within the hypersthene and anhedral ore-minerals, chiefly magnetite, connected with the "acid extract" [white]. The "acid extract" is plagioclase.

× 59

FIG. 54

Polished section of ore-bearing hypersthenite. The ore-minerals are magnetite [*m*] and bornite [*b*]. The general relations suggest that magnetite is partially replaced by bornite.

× 10

FIG. 55

Thin section showing anthophyllite [*an*] and talc (?) [*ta*] in pyrrhotite [black]. The sharp-pointed anthophyllite needles cut and are later than the ore-minerals.

× 435

Fig. 52

Fig. 53

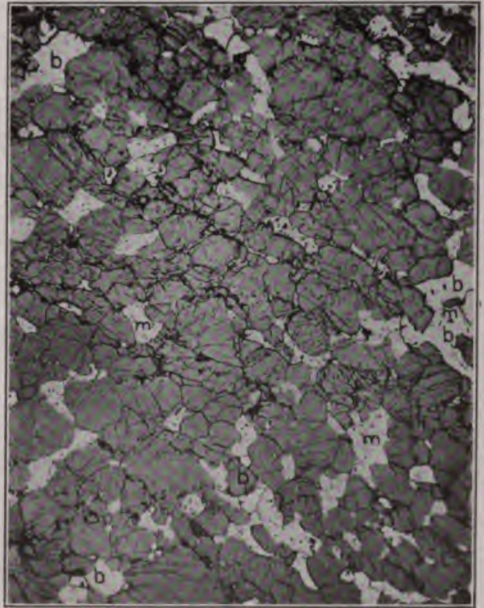

Fig. 54

Fig. 55

PLATE XIV

PHOTOMICROGRAPHS OF THIN SECTIONS OF ORE-BEARING NORITE FROM THE TWEEFONTEIN MINE, OOKIEP, SOUTH AFRICA

FIG. 56

Hypersthene [dark gray] and plagioclase [light gray] surrounded and cut by ore-minerals, magnetite and a little chalcopyrite. Euhedral magnetite [designated by arrow] is developed within the silicates. Silicates are free from any kind of alteration products.

x 17

FIG. 57

A higher magnification of the lower portion of fig. 56. Magnetite is anhedral along the boundaries of the silicates and euhedral [see arrow] within the plagioclase.

x 49

FIG. 58

Hypersthene [gray] and plagioclase [white] surrounded and replaced by ore-minerals. Anhedral areas are chalcopyrite and bornite. Subhedral crystals within the hypersthene are magnetite.

x 11

FIG. 59

A higher magnification of the plagioclase in the left side of fig. 58. The ore-minerals are "eating in" along albite twinning lamellae.

x 23

Fig. 56

Fig. 57

Fig. 58

Fig. 59

PLATE XV

PHOTOMICROGRAPHS OF A POLISHED SECTION OF ORE-BEARING NORITE, TWEEFONTEIN MINE, OOKIEP, SOUTH AFRICA

FIG. 60

The ore-minerals shown in the slide are bornite [*b*], chalcopyrite [*cp*], magnetite [*m*], lined with ilmenite. (Hematite is shown in fig. 61.) Silicates are plagioclase [*pl*], hypersthene [*hy*], biotite [*bi*], and apatie [*ap*]. Note especially magnetite cutting hypersthene in the upper portion of the photograph, and bornite and chalcopyrite penetrating biotite on the left.

x 9

FIG. 61

Photograph from the same polished section as shown in fig. 60, showing hematite [*h*], and magnetite [*m*] intergrown with ilmenite lamellae.

x 18

FIG. 62

Photograph from the same section as shown in figs. 60 and 61. Chalcopyrite $[cp]_2$, and bornite [*b*] cut by a veinlet of anthopyllite [black needles], along which is developed a second generation of chalcopyrite (shown faintly at $[cp]_2$).

x 150

FIG. 63

A higher magnification of the veinlet shown in fig. 62. Bornite [gray], anthophyllite [black], and chalcopyrite of the second generation [white].

x 920

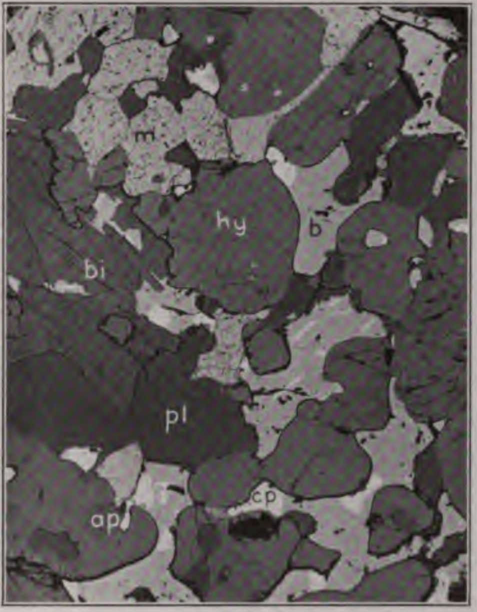

Fig. 60

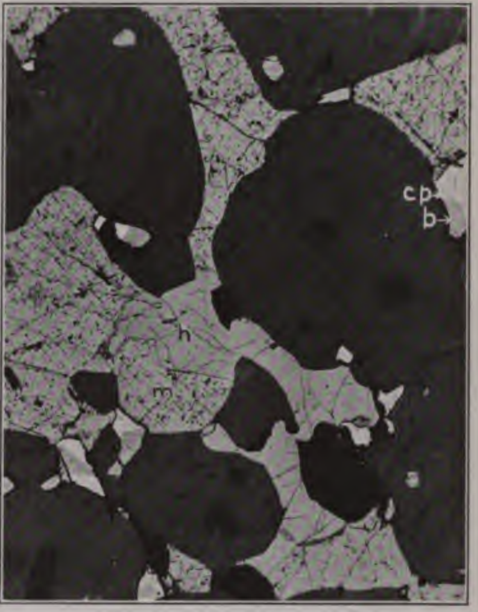

Fig. 61

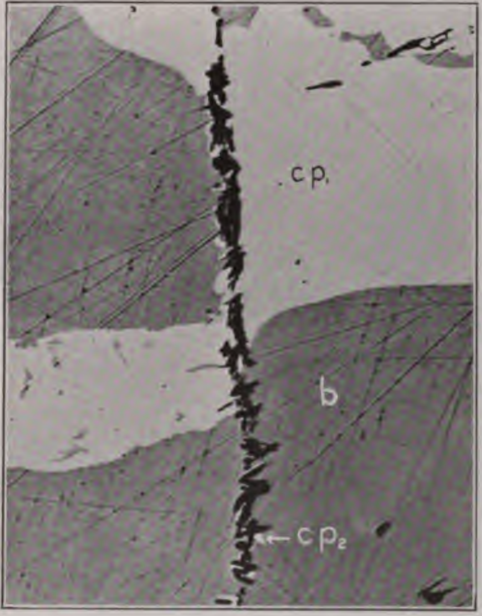

Fig. 62

Fig. 63

PLATE XVI

PHOTOMICROGRAPHS OF SECTIONS OF ORE-BEARING MICA DIORITE, OOKIEP EAST MINE, OOKIEP, SOUTH AFRICA

FIG. 64

Polished section showing pyrrhotite [*p*] residual in chalcopyrite [*cp*] and sulfid veinlets in the silicates.

x 10

FIG. 65

Thin section. The ore-minerals [black] are pyrrhotite and chalcopyrite. The primary silicate is plagioclase [gray]. The secondary silicates cut the ore-minerals and plagioclase as veinlets in the lower portion of photograph, and are distributed as specks in the sulfids. The alteration is subsequent to ore-formation.

x 18

FIG. 66

From the same thin section as fig. 65. The veinlets of sulfids are not a later generation of ore, nor are they due to rearrangements. This fact is shown in fig. 69.

x 45

FIG. 67

A group of subhedral magnetite crystals [*m*], a few of which are partially replaced by pyrrhotite [*p*] [at the bottom of the photograph].

x 51

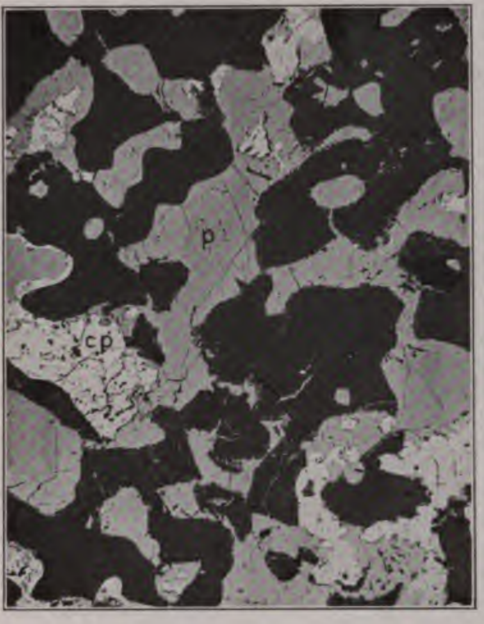

Fig. 64

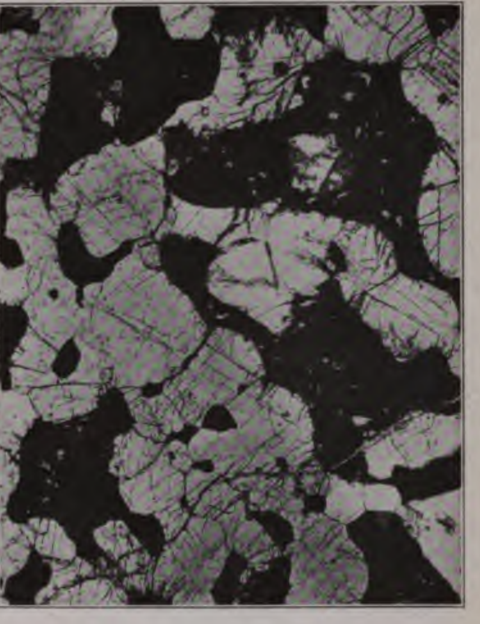

Fig. 65

Fig. 66

Fig. 67

PLATE XVII

PHOTOMICROGRAPHS OF POLISHED SECTIONS OF ORE-BEARING MICA DIORITE, OOKIEP EAST MINE, OOKIEP, SOUTH AFRICA

FIG. 68

Pyrrhotite [*p*] and chalcopyrite [*cp*] cutting the feldspars in sharp veinlets and penetrating the cleavage planes of the biotite [top of photograph].

x 10

FIG. 69

The chalcopyrite veinlet on the right is cut sharply by chloritic alteration products, and therefore the veinlets are not connected with the rock alteration, but antedate the latter. On the left a biotite crystal [*bi*] is penetrated by chalcopyrite along cleavage planes.

x 153

FIG. 70

A biotite-rich segregation in the diorite, with the sulfids, chalcopyrite [*cp*] and pyrrhotite [*p*], penetrating the cleavages of the biotite.

x 11

FIG. 71

Brush-like pentlandite (?) [*pn*], replacing pyrrhotite [*p*] and chalcopyrite [*cp*]. It is probably of a late generation, like that shown in figs. 18, 35, 36, 42 and 43.

x 620

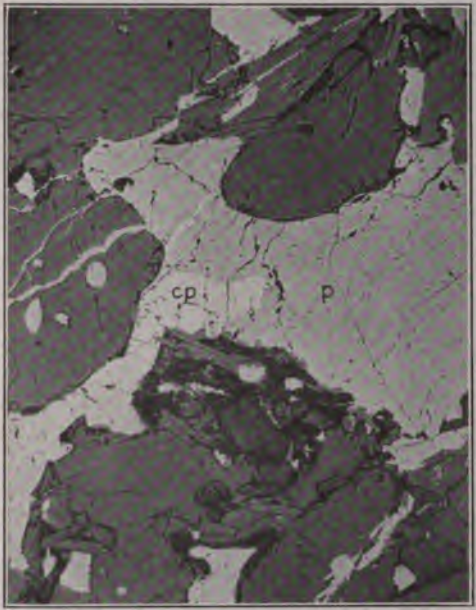

Fig. 68

Fig. 69

Fig. 70

Fig. 71

PLATE XVIII

PHOTOMICROGRAPHS OF THIN SECTIONS OF NORITE-DIORITE FROM THE ENGELS MINE, PLUMAS COUNTY, CALIFORNIA

FIG. 72

Unaltered norite-diorite showing the general relations of the ore-minerals [black] to the silicates (hypersthene [dark gray] and feldspar [light gray]). The ore-minerals are chiefly magnetite and hematite. The magnetite shows all gradations in form from euhedral to anhedral outlines.

x 22

FIG. 73

A higher magnification of a spot in the upper right-hand corner of fig. 72. Euhedral magnetite occurs within the silicates, anhedral along the boundaries. One area [indicated by arrow] shows an euhedral termination penetrating a silicate crystal, and the remaining portion is anhedral.

x 143

FIG. 74

A higher magnification of another spot in the upper right corner of fig. 72. Hook-shaped anhedra of magnetite and hematite [black] penetrating and replacing the silicates, especially biotite [*bi*].

x 195

FIG. 75

Hornblende [*ho*] rim surrounding pyroxenes [*px*] (diopside and hypersthene). This phenomenon is often observed in magmatic deposits.

x 40

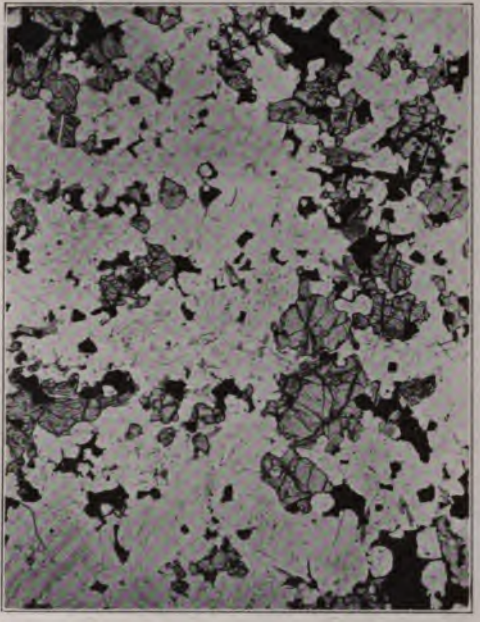

Fig. 72

Fig. 73

Fig. 74

Fig. 75

PLATE XIX

PHOTOMICROGRAPHS OF SECTIONS OF ROCKS AND ORES FROM THE ENGELS MINE, PLUMAS COUNTY, CALIFORNIA

FIG. 76

Thin section of norite-diorite showing diopside [*di*] with rim of hornblende [*ho*]. Euhedral crystals of magnetite [black] within the diopside, and anhedral crystals of magnetite and hematite [black] along its borders.

x 63

FIG. 77

Thin section of norite-diorite showing silicates [light gray and white] and ore-minerals [black], magnetite and hematite, cut by veinlets of chlorite (shown by arrow), which proves that the alteration is post-mineral.

x 36

FIG. 78

Thin section of ore-bearing granodiorite containing tourmaline [dark gray], sericitized feldspars [light gray], and ore-minerals [black], bornite and chalcocite. The feldspars and tourmaline are replaced by the ore-minerals and they in turn by sericite laths. (One is indicated by arrow in the lower right-hand corner.) This section shows local development of sericite. Most specimens, however, are not affected by sericitization.

x 23

FIG. 79

Polished section of the ore shown in fig. 78. Note the irregular hook-shaped bornite [*b*] with narrow rim of supergene chalcocite $[cc]_2$. The bornite surrounds and replaces the silicates.

x 184

Fig. 76

Fig. 77

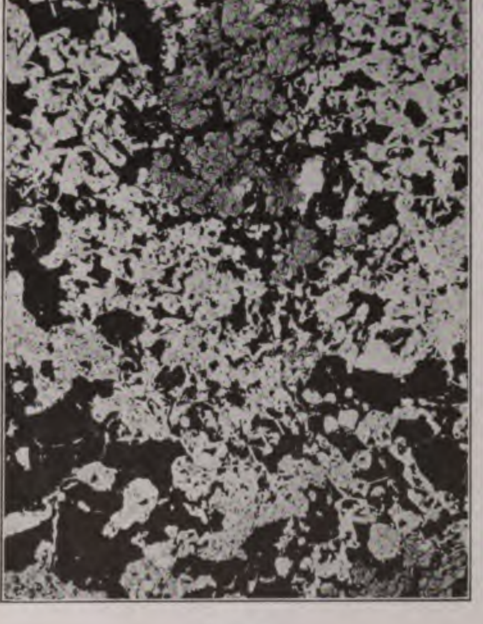

Fig. 78

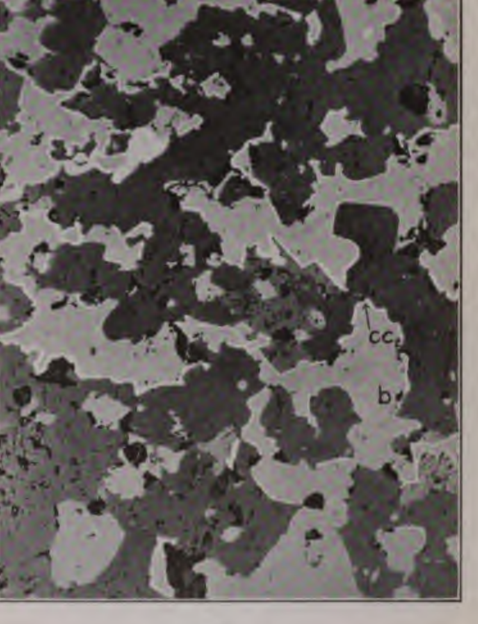

Fig. 79

PLATE XX

PHOTOMICROGRAPHS OF POLISHED SECTIONS OF ORES FROM THE ENGELS MINE, PLUMAS COUNTY, CALIFORNIA, SHOWING LOCAL REARRANGEMENT AND COPPER ENRICHMENT SUBSEQUENT TO THE MAGMATIC STAGE

FIG. 80

The photograph shows the following post-magmatic alterations of bornite [*b*]: First the development of the so-called graphic intergrowth of bornite [*b*] and chalcocite $[cc]_1$, and later the development of rims of chalcocite $[cc]_2$ around the margins of the bornite areas. The first generation of chalcocite is probably hypogene, the second generation probably supergene.

x 125

FIG. 81

Anhedron of bornite [*b*] altering to covellite [*cv*] and chalcopyrite $[cp]_2$ of the second generation. The latter develops along crystallographic directions of the bornite. This alteration is probably supergene.

x 542

FIG. 82

An area of bornite [*b*] has been replaced by covellite [*cv*] and chalcocite $[cc]_1$, and later all of these have been penetrated by chlorite [*ch*] laths. This alteration is in part along crystallographic directions of the bornite.

x 142

FIG. 83

An area of bornite [*b*] has been replaced by chlorite [*ch*] laths and by quartz [*q*] veinlets. Chalcocite $[cc]_2$ of the second generation has developed along the margin of the bornite, along the chlorite-bornite contacts, and along veinlets.

x 142

Fig. 80

Fig. 81

Fig. 82

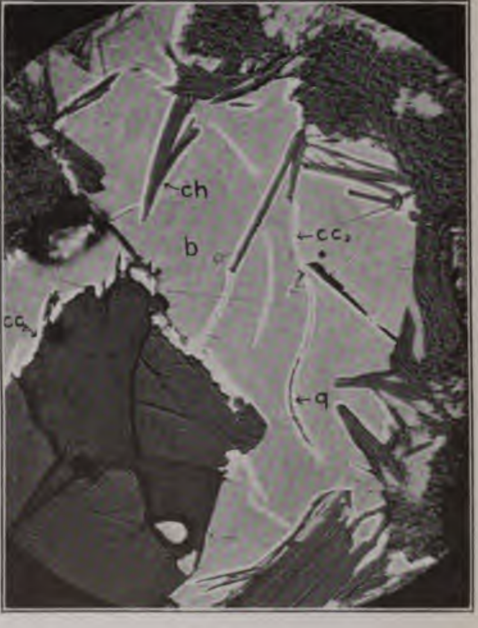

Fig. 83

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INTRODUCTION

The leading purpose of the Commission * of the International Congress of Zoology is to give stability to nomenclature. To that end numerous cases of doubt have been resolved by the Commission. But the work done thus far has been largely piecemeal, and by this method it cannot be always made consistent with itself. Recently the Commission has undertaken to fix generic names on a larger scale, covering, for example, all those in use in a given group. In some small classes of animals this has been possible. In larger ones, it demands a study of the literature more detailed than any one has yet attempted.

Recently efforts have been made to secure stability by fiat, using names more or less current, without serious regard to the law of priority. To accept this plan would merely accentuate the confusion already existing and which has arisen through just such disregard of fundamental rules.

It seems to us that the attempts thus far have mostly begun at the wrong end. The need is not to confirm modern errors but to give nomenclature a solid basis for the long future. Stability must rest on a thorough study of the foundations of biological nomenclature, after which the Commission's authority can be used to confirm the results of such studies.

There is no middle ground between using the oldest eligible names in any given group and using whatever names we please. With the latter

* The International Commission of Zoological Nomenclature consists (May 1917) of the following persons:

Carl Apstein, Berlin;
F. A. Bather, London;
Joel A. Allen, New York.
Raphael Blanchard, Paris, (President);
Ph. Dautzenberg, Paris;
Ernst Hartert, Tring, England;
Dr. Horvath, Budapest;
W. Evans Hoyle, Cardiff;
Dr. Handlirsch, Vienna;
Karl Jordan, Tring;
David Starr Jordan, Stanford University;
J. H. Kolbe, Berlin;
F. S. Monticelli, Naples;
Dr. Roule, Paris;
S. Simon, Paris;
Henry Skinner, Philadelphia;
Leonhard Stejneger, Washington;
Charles Wardell Stiles, Washington, (Secretary).

alternative, Systematic Zoology and Botany would come to a condition of hopeless despair. There can be no finality when the question of acceptance or rejection of names is left as a matter of personal preference.

Binomial nomenclature has its recognized beginning with the Tenth Edition of the *Systema Naturæ of* Linnæus, published in 1758 with the assumed date of January 1. These names of Linnæus constitute the original framework of Zoological Taxonomy. In the nomenclature of this early period, there are two main elements of doubt: the first relates to the eligibility of authors who have for one reason or another not accepted the Linnæan Code; next of authors whose works, published before the Linnæan Code, have been revised more or less and reprinted after the date of the Tenth Edition of the *Systema Naturæ*. In all of these the species are designated by a descriptive phrase, as was the custom before Linnæus began the practice of "scientific bookkeeping" in Systematic Zoology. The writings of Gronow, Schæfer, and Valmont de Bomare come under the first of these heads; those of Klein (*Gesellschaft Schauplatz*), Browne, Catesby, and Osbeck, under the other. Commerson and Plumier, whose manuscript names were published by an author who did not accept them, come under a third head. It is the judgment of the present writer, that the best interests of Ichthyology would have been served by adopting the rule followed by Jordan & Evermann (*Fishes of North and Middle America*, 1898). In this work all writers who use polynomial phrases for the designation of species are disregarded as factors in nomenclature, however regular their practice may be as to genera. It is not a question of justice to able naturalists who, like Gronow and Browne, failed to adopt the Linnæan Code, solely because they had never heard of it. It is the convenience of future naturalists which is now concerned. This would apparently be best served by the exclusion of all these.

The arguments against such exclusion are mainly two: Brisson in 1760, polynomial as to species, had a stronger grasp on the significance of genera than any other ornithologist of his time. He has been called "the Father of Ornithology." Most students of birds wish to retain Brisson's genera as foundation-stones in nomenclature. There are good reasons for accepting Brisson as an exception. Similar exceptions may be demanded in other groups. It is desirable, but not vitally necessary, that all accepted rules be general, without exception; but as a member of the International Commission of Nomenclature, the present senior author has made no objection to the recognition of Brisson. The other argument is this: these writers have published generic names which

appear in systematic lists, like that of Sherborne (*Index Animalium*). The Commission has already approved the names of Gronow and Commerson. If the present Commission should decide to reject the whole series of "irregulars," some future Commission may reverse the decision, placing the element of priority above that of regularity. This possibility we cannot forestall, while if once accepted there would be no successful movement for their rejection. Previous decisions of the Commission, as to Gronow and Commerson, point in the direction of general acceptance.

It is especially important to have the status of questioned authors determined as soon as may be, not only for the convenience of ichthyologists but for workers in other fields which may be affected by questions of preoccupation.

More important than the question of acceptance or rejection of some or all of the questioned genera, is the securing of a final decision. This the Commission will be asked to make as soon as practicable. Pending this decision it is perhaps wise for systematic workers to refrain from acceptance of the names questioned.

The other problem is the assignment of generic types to the genera of authors who had no conception of types. In doing this we have followed as closely as may be the rules adopted by the Congress of Zoology, having especial regard to the "first reviser." In some cases we have been in doubt on account of conflicting usages or even rules. But in such cases the weight of authority of the Commission when exercised should serve to turn the scale. With the authors subsequent to Cuvier, 1829, this matter rarely offers any embarrassment. The later authors mostly look upon a genus, not as a pigeon-hole with arbitrary boundaries, but rather as a group of species, with certain definite structural marks clustered around some definite species, the type of the genus.

The writer asks from his colleagues the fullest criticism both as to matters of fact and of opinion, before placing the contents of this paper formally before the International Commission. We would especially request information concerning omissions. There are no doubt numerous generic names overlooked in dictionaries and in obscure publications.

We have arranged in chronological order the generic names of fishes published in the first seventy-five years of the history of ichthyological taxonomy. The determination of the validity of genera is treated only incidentally. Our main problem is the fixation of the type.

STANFORD UNIVERSITY, CALIFORNIA, June 1, 1917.

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The Genera of Fishes from Linnæus to Cuvier 1758 to 1833

I. LINNÆUS, *Systema Naturæ*, Ed. X, Vol. I, 1758.

KARL LINNÉ (CAROLUS LINNÆUS).

The generic names of Linnæus represent, with one change and two or three additions, the system of Ichthyology as developed in 1738 by his friend and fellow-student, Peter Artedi, a naturalist whose knowledge of fishes was far greater than that of Linnæus. The types of most of the Linnæan genera have been accepted by common consent. As a rule we have not questioned the current application unless compelled to do so by the insistence of established rules.

Petromyzon Linnæus, 230, after Artedi; type PETROMYZON MARINUS L.
Unquestioned.

Raja Linnæus, 231, after Artedi; type RAJA BATIS L.
Spelled also RAIA, by authors.

Squalus Linnæus, 231, after Artedi; type SQUALUS ACANTHIAS L.
Restriction to S. ACANTHIAS and relatives, Rafinesque, *Indice d'Ittiologia Siciliana,* 1810, 45, and by Gill, *Proc. Acad. Nat. Sci. Phila.,* 1862, 497. Gray, *Cat. Chond.,* 1851, following Bonaparte, 1838, uses the name SQUALUS for the allies of CARCHARHINUS COMMERSONIANUS. But this use of the name is no more a specification of a type than is that of Rafinesque, and the more formal choice of type by Gill reinforces the former. Swainson, 1838, chooses CARCHARODON CARCHARIAS L.

Chimæra Linnæus, 236; type CHIMÆRA MONSTROSA L.
Unquestioned.

Lophius Linnæus, 236, after Artedi; type LOPHIUS PISCATORIUS L.
Unquestioned.

Acipenser Linnæus, 237, after Artedi; type ACIPENSER STURIO L.
Unquestioned.

Muræna Linnæus, 244, after Artedi; type MURÆNA HELENA L.
Unquestioned, except by Bleeker, who takes as type MURÆNA ANGUILLA L., the first species named by Artedi.

Scomber Linnæus, 297, after Artedi; type SCOMBER SCOMBRUS L.
By common consent.

Mullus Linnæus, 299; type MULLUS BARBATUS L.
By common consent.

Trigla Linnæus, 300, after Artedi; type TRIGLA LYRA L.
By common consent.

Cobitis Linnæus, 300, after Artedi; type COBITIS TÆNIA L.
By common consent.

Silurus Linnæus, 304, after Artedi; type SILURUS GLANIS L.
By common consent.

Loricaria Linnæus, 307, type LORICARIA CATAPHRACTA L.
Monotypic.

Salmo Linnæus, 308, after Artedi; type SALMO SALAR L.
By common consent.

Trutta Linnæus, as "TRUTTÆ," 308; type SALMO TRUTTA L.
Type by tautonomy.

Osmerus Linnæus, as "OSMERI," 310, after Artedi; type SALMO EPERLANUS L.
By common consent.

Coregonus Linnæus, as "COREGONI," 310, after Artedi; type SALMO LAVARETUS L.
By common consent.

Characinus Linnæus, as "CHARACINI," 311, after Gronow; type SALMO GIBBOSUS L.

First restriction by Gill, *Proc. U. S. Nat. Mus.*, 1895, 215. Replaces CHARAX Gronow, EPICYRTUS Müller & Troschel, ANACYRTUS Günther. Its use hinges on its eligibility, as Linnæus used only the plural form CHARACINI as a section SALMO. If not accepted, CHARAX Gronow (1763), Scopoli (1777), would replace it, with the same type. The same slight doubt applies to TRUTTA, OSMERUS and COREGONUS, all used in the plural form only by Linnæus. In our judgment all are eligible.

Fistularia Linnæus, 312; type FISTULARIA TABACARIA L.
Monotypic.

Esox Linnæus, 313; type ESOX LUCIUS L.

This type was indicated, somewhat arbitrarily, in Opinion 58 of the International Commission, accepting the view of Cuvier, and current usage both before and after Linnæus. Klein chose the name LUCIUS for the Pike, this name being adopted in the *Gesellschaft Schauplatz*. Rafinesque first separated the marine garfishes from the pike, calling the former Esox, the latter LUCIUS. But neither ever stated formally that Esox BELONE L. was the type of Esox. In view of the arguments available on either side, we may "let sleeping dogs lie," and follow common custom, strengthened by the authority of the Commission.

Argentina Linnæus, 315, after Gronow, (*Museum Ichthyologicium*, a pre-Linnæan work); type ARGENTINA SPHYRÆNA L.

Monotypic.

Atherina Linnæus, 315, after Artedi; type ATHERINA HEPSETUS L.

Monotypic.

Mugil Linnæus, 316, after Artedi; type MUGIL CEPHALUS L.

Monotypic.

Exocœtus Linnæus, 316; type EXOCŒTUS VOLITANS L. = E. EVOLANS L. (= HALOCYPSELUS Weinland).

Monotypic.

Polynemus Linnæus, 317, after Gronow and Artedi; type POLYNEMUS PARADISEUS L.

The first real restriction seems to be that of Günther, *Cat. Fishes*, II, 1860, 319. No type is specified, but the non-congeneric species, P. QUINQUARIUS L., is removed to form the genus PENTANEMUS, a name originally employed by Artedi, but changed to POLYNEMUS by Gronow. As this species, QUINQUARIUS, was the only one known to Artedi or to Gronow, Dr. Gill, with numerous writers, ourselves included, has regarded it as the type of POLYNEMUS. But common usage with the formal selection of P. PARADISEUS L. as type by Jordan & Gilbert, *Synopsis Fishes*, 1883, should prevail.

Clupea Linnæus, 317, after Artedi; type CLUPEA HARENGUS L.

Unquestioned.

Cyprinus Linnæus, 320, after Artedi; type CYPRINUS CARPIO L.

Unquestioned.

Mormyrus Linnæus, 327; type MORMYRUS CYPRINOIDES L.

Unquestioned.

Balistes Linnæus, 327, after Artedi; type BALISTES VETULA L.

Unquestioned.

Ostracion Linnæus, 330; type OSTRACION CUBICUS L.

As restricted by Swainson 1839, by Bleeker 1865, and in recent usage.

Unquestioned, except by Kaup, who takes as type O. TRIQUETER L., a species referred to LACTOPHRYS Swainson. O. CUBICUS L. is type of CIBOTION Kaup.

Tetraodon Linnæus, 332, after Artedi; type TETRAODON TESTUDINEUS L.

This genus has been variously treated by authors, but justice and convenience are best served by the choice of T. TESTUDINEUS as type. Bleeker, *Atlas Ichth.*, 1865, appears to be the first reviser. He observes: "C'est une de ces espèces qui est devenue le type du genre Linnéen . . . en effet le TETRAODON TESTUDINEUS, qui est la première des espèces de TETRAODON de la Dixième Edition du *Systema Naturæ*." Several writers have since indicated as type T. LINEATUS L. a species of OVOIDES.

Diodon Linnæus, 334, after Artedi; type DIODON HYSTRIX L.

Unquestioned, except by Bleeker, who takes the first species named, DIODON ATINGA L.

Centriscus Linnæus, 336, after Gronow; type CENTRISCUS SCUTATUS L.

Monotypic, a fact overlooked by various authors who choose CENTRISCUS SCOLOPAX L., 1766.

Syngnathus Linnæus, 336, after Artedi; type SYNGNATHUS ACUS L.

By common usage. The earliest restriction as approved by the International Commission is that of Jordan, Opinion, 45, 103, 1912.

Pegasus Linnæus, 358, after Gronow; type PEGASUS VOLITANS L.

Monotypic.

II. GUNNER, *Nachricht von Berglachs, welche* CORYPHÆNOIDES RUPESTRIS *genannt werden kann*: Throndhjemske Selskab, Schriften III, 1761.

JOHAN ERNST GUNNER.

Coryphænoides Gunner, 43, 50; type CORYPHÆNOIDES RUPESTRIS Gunner.

III. SCHÆFER, *Piscium Bavarico Ratisbonensium,* 1761.

JACOB CHRISTIAN SCHÆFER.

The descriptions in this paper are exact and very elaborate ("in universum describiendibus"). The nomenclature is eccentric—in part mononomial, and the names are perhaps not exactly used in the sense of genera. The perch is called PERCA VULGARIS and again PERCA FLUVIATILIS.

Names perhaps not eligible as mononomial:

Cernua Schæfer, 37; type CERNUA SEU PERCA FLUVIATILIS MINOR Schæfer = PERCA CERNUA L.

Equivalent, if accepted, to GYMNOCEPHALUS Bloch, ACERINA Güldenstadt, CERNUA Fleming.

Schraitzer Schæfer, 38; type SCHRAITZER Ratisbonensium = PERCA SCHRÆTZER L.

Equivalent to LEPTOPERCA Gill.

Asperulus Schæfer 59; type ZINDEL RATISBONENSIS Schæfer = PERCA ZINGEL L.

Equivalent to ZINGEL Oken.

Asper Schæfer 59; type ASPER VERUS Schæfer, "Streber ratisbonensis" = PERCA ASPER L.

Equivalent to ASPRO Cuvier, not of Commerson.

IV. OSBECK, *Reise durch China*, 1762.

PER OSBECK.

Osbeck, a pupil of Linnæus, published in 1757 the record of his travels in China. This work is wholly binomial, but being earlier than 1758, the Latin edition, *"Iter Chinensis,"* 1757, cannot be used in nomenclature. The German edition, *Reise durch China,* bears the date of 1762, and is here considered. A Swedish version dates from 1765, an English edition from 1771. The case is exactly parallel with that of Hasselquist's *"Iter Palestinum,"* published in 1757, and reprinted in German in 1762. Hasselquist, like Osbeck, was a pupil of Linnæus, and adopted the Linnæan Code. In Opinion 57, the Commission of Nomenclature rejected Hasselquist's work and its translation. "The German translation by Gadebusch, published in 1762, does not give validity to the names published in the original edition in 1757." The present writers question the wisdom of this decision.

The names of Osbeck are questioned as translations of work prior to 1758.

Apocryptes Osbeck, 130, 1762; type APOCRYPTES CHINENSIS Osbeck, GOBIUS PECTINIROSTRIS Gmelin.

APOCRYPYTES is close to BOLEOPHTHALMUS but distinct. APOCRYPTES Cuvier is a different genus.

Albula Osbeck, 309, 1762; type ALBULA CHINENSIS Osbeck.

Same as SALANX Cuvier, not ALBULA Gronow 1763. If accepted, the genus commonly called ALBULA must receive a new name, BUTYRINUS Lacepède.

V. GRONOW, *Zoophylaceum;* ZOOPHYLACII *Gronoviana . . . Animalia quæ in museo suo adservat, etc.*, 1763.

LORENZ THEODOR GRONOW (LAURENTIUS THEODORUS GRONOVIUS).

In this work of Gronow, printed in 1763, before its author had become acquainted with the *Systema Naturæ,* the genera of fishes are well defined, in a system which runs closely parallel with the system of Artedi (1738), but the species, as with Artedi, have polynomial designations only. In addition to the genera earlier named by Artedi and Linnæus, Gronow has a number of new names. Two of these, AMIA and HEPATUS, conflict with Linnæan genera of 1766. The completed manu-

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In this work of Gronow, printed in 1763, before its author had become acquainted with the *Systema Naturæ*, the genera of fishes are well defined, in a system which runs closely parallel with the system of Artedi (1738), but the species, as with Artedi, have polynomial designations only. In addition to the genera earlier named by Artedi and Linnæus, Gronow has a number of new names. Two of these, AMIA and HEPATUS, conflict with Linnæan genera of 1766. The completed manu-

script work of Gronow, written in 1780, called *Systema Ichthyologicum*, in which binomial names were attached to species, after the Linnæan fashion, became the property of the British Museum, by which institution it was published in 1854. This work, as edited by John Edward Gray, does great credit to the scientific discrimination of Gronow; but at that late date, exactly a hundred years after Gronow's first paper, "*Museum Ichthyologicum*," nearly all of his new names became synonyms.

Fortunately for the interests of nomenclature, most of Gronow's names were adopted in 1777 by Scopoli, *Introd. Hist. Nat.* Several other names have been used by subsequent authors, as Gmelin, Bloch and Cuvier; so that the adoption of the names of Gronow works less confusion in the system than might be expected. The suppression of AMIA, LIPARIS, ZOARCES, CONGER, and SCARUS, with the transposition of AMIA, are the results most to be regretted. As the few new names of Gronow have lain unnoticed for a century and a half, it seems a pity to revive them. The present writer believes, as already stated, that it would be a wise rule to exclude from the system all post-Linnæan writers who failed to adopt the binary designation of species. As however Brisson, 1760, "the Father of Ornithology," was a writer of this type, it may be possible to make an exception in his case, preserving his genera of Birds. But Ichthyology gains little to atone for the confusion resulting from the introduction at this late day of the names of Gronow, Klein and other polynomial writers not hitherto absorbed into the system. The generic names of Gronow have been, however, formally accepted by the International Commission of Zoological Nomenclature (Opinion 20, Smithsonian Miscellaneous Contributions, No. 1938): "Gronow, 1763, is binary, though not consistently binomial. Article 25 demands that an author be binary and Article 2 demands that generic names shall be uninomial. Under these articles, Gronow's names are to be accepted as complying with the conditions prescribed by the Code to render a name available under the Code."

The eligibility of the generic names of Gronow is questioned as not conforming to the Linnæan code in the terminology of species.

Callorhynchus Gronow, 31; type CHIMÆRA CALLORHYNCHUS L. (CALLORHYNCHUS PINNA DORSI etc. Gronow).

Unquestioned: accepted by later writers.

Cyclogaster Gronow, 55; type CYCLOPTERUS LIPARIS L. (CYCLOGASTER BELGIS KRINGBURGK (Gronow).

The name LIPARIS used for this genus by Artedi in 1738 was changed to CY-

CLOGASTER by Gronow. LIPARIS was restored by Scopoli in 1777, and has been used by nearly all subsequent authors.

Gonorhynchus Gronow, 56; type CYPRINUS GONORHYNCHUS Gmelin.

Monotypic. The name was adopted by Schlegel, 1846, replacing RHYNCHÆUS Richardson. Also by Scopoli, 1777.

Uranoscopus Gronow, 57; type COTTUS GOBIO L.

Synonym of COTTUS L.

Cynædus Gronow, 60; type SPARUS AURATA L. (CYNÆDUS CAUDA LUNULATA etc. Gronow).

This genus is an assemblage of Sparoid fishes, essentially equivalent to SPARUS of Linnæus, and includes species of several modern genera. Jordan (Smithson. Publ. No. 1938: *Opinions on zoological nomenclature*) has proposed to treat CYNÆDUS as a synonym of SPARUS, having SPARUS AURATA as type.

Holocentrus Gronow, 65; type HOLOCENTRUS SOGO Bloch (HOLOCENTRUS MAXILLA SUPERIORE LONGIORE Gronow).

This name, taken from Artedi, was revived by Scopoli, 1777, and by Bloch, 1790, who changed the spelling to HOLOCENTRUM, the form used by Artedi. This neuter form has been used by most authors from Cuvier to Günther.

Coracinus Gronow, 66; type DIPTERODON CAPENSIS Cuv. & Val. (CORACINUS CAUDA-LUNATA Gronow).

Not DIPTERODON Lacepède. If accepted, replaces DICHISTIUS Gill.

Scarus Gronow, 67; type LABRUS VIRIDIS L. (SCARUS VIRIDIS Gronow).

This genus of Gronow unfortunately contains no species of the group later called SCARUS, the two other species enumerated being CICHLIDS from Surinam.

Callyodon Gronow, 72; type SCARUS CROICENSIS Bloch (CALLIODON CAPITE SUBACUTO Gronow).

CALLYODON, if eligible, must replace SCARUS Forskål, 1775, as the name of this large and wide-spread genus. The name SCARUS of Gronow, applied to a species of LABRUS, antedates its use for a parrot-fish. The genus called CALLIODON by Cuvier (C. SPINIDENS), is distinct from CALLYODON of Gronow (CALLIODON of Bloch & Schneider), and must stand as CRYPTOTOMUS Cope. Revived by Scopoli, 1777.

Enchelyopus Gronow, 77, after Klein; type BLENNIUS VIVIPARUS L. (ENCHELYOPUS CORPORE LITURIS etc. Gronow).

This genus as proposed by Klein in 1744 contained a variety of fishes, eel-shaped but with ventral fins. As used by Gronow it is practically equivalent to ZOARCES Cuvier, and to this type it was restricted by Gill, 1863. ENCHELYOPUS Bloch & Schneider (type GADUS CIMBRIUS L., a species unknown to Gronow), should stand as RHINONEMUS Gill. ENCHELYOPUS Gronow must unfortunately supersede ZOARCES Cuvier.

Pholis Gronow, 78; type BLENNIUS GUNNELLUS L. (PHOLIS MACULIS ANNULATUS etc. Gronow).

Revived by Scopoli, 1777. Replaces MURÆNOIDES Lacepède and GUNNELLUS Cuvier, (not PHOLIS Cuv. & Val.). Monotypic.

Amia Gronow, 80; type APOGON MOLUCCENSIS Cuv. & Val. (AMIA CAPUT CATHEOPLATEUM Gronow).

Equivalent to APOGON Lacepède, 1802.

Eleotris Gronow, 83; type GOBIUS PISONIS Gmelin = ELEOTRIS GYRINUS Cuvier & Valenciennes (ELEOTRIS CAPITE PLAGEOPLATEO etc. Gronow).

The name ELEOTRIS was used for the same group by Bloch & Schneider in 1801, and by all later authors.

Clarias Gronow, 100; type CLARIAS ORONTIS Günther (CLARIAS Gronow).

Accepted by Scopoli, 1777, and by other writers. Monotypic.

Albula Gronow, 102; type ESOX VULPES L. = ALBULA CONORHYNCHUS Bloch & Schneider.

Revived by Bloch & Schneider, 1801. Antedated by ALBULA Osbeck. Equivalent to BUTYRINUS Lacepède. Also used by Scopoli, 1777.

Aspredo Gronow, 102, after Linnæus, 1754; type SILURUS ASPREDO L. (ASPREDO CIRRIS OCTO Gronow).

Anableps Gronow; type COBITIS ANABLEPS L.

Anostomus Gronow, 112; type SALMO ANOSTOMUS L. (ANOSTOMUS Gronow).

Adopted by Müller & Troschel, 1845. Equivalent to SCHIZODON Agassiz, 1829. Monotypic. Revived by Scopoli, 1777.

Synodus Gronow, 112; type SALMO SYNODUS L.

This genus, equivalent to SAURUS Cuvier, was revived by Scopoli, 1777. Monotypic.

Hepatus Gronow, 113; type TEUTHIS HEPATUS L. = CHÆTODON CHIRURGUS Bloch, not ACANTHURUS HEPATUS Cuv. & Val. (HEPATUS MUCRONE REFLEXO Gronow).

HEPATUS Gronow is based on two species, on which two Linnæus based his genus TEUTHIS. The latter is a substitute for the former, and the two were accepted as identical by Scopoli. Of the two species mentioned by Gronow, HEPATUS L. and JAVUS L., Gronow had, according to Dr. Günther, a specimen of the first. This we may take as type of both HEPATUS and TEUTHIS HEPATUS. This example belonged to the species called later CHÆTODON CHIRURGUS by Bloch. This species must be regarded as the type of the genus HEPATUS. Cuvier & Valenciennes have used the name HEPATUS L. for an East Indian species, COLOCOPUS LAMBDURUS Gill. They were mistaken in supposing that this species was the one examined by Gronow. The restriction here made is that of the first reviser, Jordan, Tanaka & Snyder, *Cat. Fish Japan,* 1913, 214. If accepted, HEPATUS replaces TEUTHIS and ACANTHURUS.

Umbra (Krämer) Gronow, 114; type CYPRINODON KRÄMERI Walbaum. (UMBRA KRAMERI Gronow).

Revived by Scopoli, 1777, and Müller, 1842, as UMBRA CRAMERI Müller.

Erythrinus Gronow, 114; type SALMO ERYTHRINUS Bloch & Schneider, 1801 (= ERYTHRINUS Gronow).

The name was revived by Müller & Troschel, 1846, and is in general use. Monotypic. Used also by Scopoli, 1777.

Cataphractus Gronow, 115; type PEGASUS DRACONIS L. (CATAPHRACTUS CORPORE TETRAGONE Gronow).

This genus is a synonym of PEGASUS L.

Solenostomus Gronow, 119; type FISTULARIA TABACARIA L. (SOLENOSTOMUS CAUDA BIFURCA etc. Gronow).

SOLENOSTOMUS is equivalent to FISTULARIA. The genus SOLENOSTOMUS Lacepède, 1803, typified by FISTULARIA PARADOXA Pallas, must receive a new name, if the names of Gronow are accepted.

Charax Gronow, 123; type SALMO GIBBOSUS L. (CHARAX MAXILLA INFERIORE etc. Gronow).

This name is equivalent to CHARACINI L.=EPICYRTUS Müller & Troschel, 1846, said to be preoccupied, and ANACYRTUS Günther, 1864, presented as a substitute for EPICYRTUS, all with the same type. CHARAX Risso (C. PUNTAZZO) belongs to the very different family SPARIDÆ. Revived by Scopoli, 1777.

Mystus Gronow, 124; type BAGRUS HALEPENSIS Cuv. & Val. (MYSTUS CIRRIS OCTO CAPITE LONGIORIBUS Gronow).

The genus MYSTUS as defined by Gronow contains five species, not congeneric. The name is taken from Russell's *History of Aleppo,* who describes the species called BAGRUS or HYPSELOBAGRUS HALEPENSIS as MYSTUS. Of the generic names included, that of HYPSELOBAGRUS Günther, 1864, is the most recent. The species named "MYSTUS" by Russell may be taken as the type of "MYSTUS" which will, if accepted, supersede HYPSELOBAGRUS. MYSTUS Lacepède, 1805, (MYSTUS CLUPEOIDES Lacepède) is a species of COILIA Gray, 1831, an Engraulid fish. Also Scopoli.

Plecostomus Gronow, 127, after Artedi; type LORICARIA PLECOSTOMUS L. (PLECOSTOMUS DORSO DIPTERYGIO Gronow).

If accepted, replaces HYPOSTOMUS Lacepède; it is now in general use.

Callichthys Gronow, 127; type SILURUS CALLICHTHYS L. (CALLICHTHYS CIRRIS Gronow).

Unquestioned, being accepted by later writers.

Mastacembelus Gronow, 132; type OPHIDIUM SIMACK Walbaum, 1792 = RHYNCHOBDELLA HALEPPENSIS Bloch & Schneider, 1801 (MASTACEMBELUS MAXILLIS SUBACUTIS Gronow).

Revived by Cuvier & Valenciennes. The generic name RHYNCHOBDELLA Bloch & Schneider included both species assigned by Gronow to MASTACEMBELUS. In dividing the group, Cuvier & Valenciennes assigned the former name to OPHIDIUM ACULEATUM Bloch, Gronow's second species, leaving MASTACEMBELUS for his first. Before Gronow, Klein, 1744, had used the name MASTACEMBELUS for an entirely different group. In this he had been followed by Bleeker, who recognized, at first, generic names of earlier date than 1758.

Channa Gronow, 135; type CHANNA ORIENTALIS Bloch & Schneider, 1801 (CHANNA Gronow).

This monotypic genus was accepted by Bloch & Schneider, 1801, and Scopoli.

Gasteropelecus Gronow, 135; type CLUPEA STERNICLA L. (GASTEROPELECUS Gronow).

Monotypic. The name was revived by Pallas in 1769.

Leptocephalus Gronow, 135; type LEPTOCEPHALUS MORRISI Gmelin, the larva of MURÆNA CONGER L. (LEPTOCEPHALUS Gronow).

This name, based on a larval conger, and revived by Scopoli in 1777, is held to replace CONGER Houttuyn, 1764, and of Cuvier, 1817, given to the adult of the same species. As LEPTOCEPHALUS has been in use more than a century as the collective name of the peculiar translucent expanded larvæ of the Conger and other eels, it would be well to restrict its use to those forms, reserving the genus to which the type belongs, the earliest name given to the adult fish, CONGER Houttuyn.

Gymnogaster Gronow, 136; type TRICHIURUS LEPTURUS L. (GYMNOGASTER Gronow).

Equivalent to TRICHIURUS L. Monotypic.

Pteraclis Gronow, 136; type CORYPHÆNA VELIFERA Pallas, 1770 (PTERACLIS PINNATA Gronow) 1777.

The name PTERACLIS was used by Gronow, 1772. It is monotypic and unquestioned.

VI. LINNÆUS, *Museum Adolphi-Frederici*, II, 1764.

CAROLUS LINNÆUS.

Cepola Linnæus, 63; type CEPOLA RUBESCENS L. = C. TÆNIA L. (also in *Syst. Nat.*, 1766.)

VII. HOUTTUYN, *Natuurlike Historie volgens den Heer Linnæus*, 1764.

MARTIN HOUTTUYN.

This work we have not seen. Mr. Garman (in lit.) quotes:

Conger Houttuyn, VII, 103; type MURÆNA CONGER L.

This name might well be retained for the Conger eel, leaving LEPTOCEPHALUS to its time-honored special use as a designation for the larval forms of Conger and similar eels.

Torpedo Houttuyn, VII, 453; type (not named) RAJA TORPEDO L.

Apparently this fixes the name TORPEDO on the Electric Ray.

VIII. LINNÆUS, *Systema Naturæ*, Ed. XII, 1766.

CAROLUS LINNÆUS.

This edition contains four genera in addition to those given in the Tenth Edition.

Cepola Linnæus, 445; type C. TÆNIA L. = C. RUBESCENS L.

Unquestioned.

Amia Linnæus, 500; type A. CALVA L.

The generic name AMIA appears in the Twelfth Edition of the *Systema Naturæ*, in 1766. It had been used earlier by Gronow, in 1763, for a percoid genus, later called APOGON by Lacepède.

In the opinions already rendered by the Commission, it was decided that the generic names in Gronow's *Zoophylaceum*, published in 1763, between the tenth and twelfth editions of the *Systema Naturæ*, should be adopted, although his names for species were polynomial. Gronow was an excellent ichthyologist, with broader knowledge than Linnæus, and later adopted the Linnæan nomenclature. In view of the fact that his names are not in current usage, and that he had not then accepted binomial nomenclature, most recent authors have rejected them, unless revived by some binomial writer. The transfer of AMIA from the ganoid to a percoid genus is, however, peculiarly undesirable, and it may be urged that general convenience justifies a special exception in this case. If AMIA be used for APOGON, AMIA L. is replaced by AMIATUS Rafinesque, 1815.

Teuthis, 507, after Browne; type CHÆTODON CÆRULEUS Bloch = TEUTHIS HEPATUS L. in part.

The name TEUTHIS was applied by Linnæus in the twelfth edition of the *Systema Naturæ*, to the two species which formed the genus HEPATUS of Gronow, in 1765. These were named TEUTHIS HEPATUS and TEUTHIS JAVUS. The name TEUTHIS was borrowed from Browne, a non-binomial author. The two Linnæan species belong to different families. The species first named HEPATUS may be regarded as the type of HEPATUS, as already indicated. The name TEUTHIS should properly go with T. HEPATUS, as the name is borrowed from Browne, who applied it to a single species, confused with TEUTHIS HEPATUS by Gronow and Linnæus, the CHÆTODON CÆRULEUS of Bloch. This species is a near relative of the type of HEPATUS. This decision follows the arguments of Dr. Gill. It is reasonable, but not above question. Meanwhile several authors, notably Cantor and Günther, use TEUTHIS for T. JAVUS (SIGANUS Forskål), while others suppress it altogether. Still others misspell it, as THEUTYS, THEUTIS, etc.

Elops Linnæus, 508; type ELOPS SAURUS L.

Monotypic.

IX. MÜLLER, *Delineationes Naturæ,* II, 1767, 141 (fide Sherborne, *Index Animalium*).

PHILIP LUDWIG STATIUS MÜLLER.

Not seen by us.

Acus Müller, 141; type probably SYNGNATHUS ACUS L.

Equivalent to SYNGNATHUS L.

Orbis Müller, 141; type probably DIODON HYSTRIX L.

Equivalent to DIODON L.

We copy these references from Sherborne. In a memoir by Professor Müller, 1774, vol. III, p. 341, ACUS appears as a specific name under SYNGNATHUS ACUS, and again, 1774, IV, 341, as a vernacular under ESOX BELONE. Under DIODON HYSTRIX (III, 327) he quotes "ORBIS MAXIMUS SPINOSUS." Mr. Garman, who gives us these references, remarks: "I would say that neither of these is available as a generic name." Neither is used in Müller's supplement to the *Systema Naturæ,* 1776.

X. GEOFFROY, *Descriptions de 719 Plantes* etc., 1767.

ÉTIENNE LOUIS GEOFFROY.

This paper we have not seen. We copy from Sherborne.

Ichthyocolla Geoffroy, 399; type presumably ACIPENSER HUSO L.

The name, meaning fish-glue, was early applied to the fish producing it. Prior to HUSO Brandt, as a name for a subgenus of sturgeons.

Harengus Geoffroy, 405; type presumably CLUPEA HARENGUS L., in which case it is a synonym of CLUPEA.

Lucius Geoffroy, 407; type presumably ESOX LUCIUS L.

Trutta Geoffroy, 719; type presumably SALMO TRUTTA L.

XI. VALMONT DE BOMARE, *Dictionnaire Raisonné Universel d'Histoire Naturelle,* 1764, 1768, 1774, 1791.

JEAN CHRISTOPHE VALMONT DE BOMARE.

The eligibility of Valmont's names is questioned as binomial only by accident, and not accepted as genera by the author himself in 1791.

Of this work we have examined four editions, the first bearing date of 1764; the "new edition," considerably enlarged, of 1768; the second

edition, apparently mostly identical with the "new edition," 1775; and the fourth, still larger, in 1791.

The dictionary received no consideration in ichthyological nomenclature until the appearance of the elaborate treatise on the sharks of the world, "PLAGIOSTOMIA" by Samuel Garman, (*Memoirs of the Museum of Comparative Zoology at Harvard College*, vol. XXXVI, 1913).

In this work Mr. Garman makes brief reference to Valmont de Bomare as a worthy author hitherto ignored in taxonomy. "The selection of one authority because he favored binomials more than another, has led to much uncertainty among names and to many changes. It has led authors to belittle and to ignore excellent works which at their time of publication and much later ranked in accuracy and influence among the first of the scientific publications of this period." Mr. Stejneger informs me that a Danish edition of this Dictionary exists.

An examination of four editions of the *Dictionnaire* of Valmont de Bomare shows it to be a compilation pure and simple, that he did not intend to give any new scientific names to animals or plants, but that, in a few cases, he copied binomial appellations from earlier authors which might be construed as revived in a scientific sense.

It is therefore worth while to examine these cases in detail.

FIRST EDITION, 1764.

In the first edition, bearing date of 1764, there is no case of the use of anything resembling scientific nomenclature, although Valmont often gives a Latin equivalent to his French names. It is evident, however, that the work of Artedi, Klein, Gronow, and Linnæus in which genera and species are formally recognized, is unknown to him.

Thus, accompanied by fair descriptions compiled from other authors, he gives the following:

"AIOL, en Latin, SCARUS, un des plus beaux," etc. (vol. I, p. 95).

"ALOSE, ALOSA, poisson de mer qui remonte" (vol. I, p. 105).

"ANCHOIS, en Latin, APUA, petit poisson," etc. (I, 13, 3).

"ANGUILLE, ANGUILLA, poisson allongé," etc. (vol. I, p. 133).

"CONGRE, CONGER, excellent poisson," etc. (vol. II, p. 58).

"DAURADE, AURATA VULGARIS, Espèce de poisson," etc. (vol. II, p. 225).

"ÉPINOCHE, PISCIS ACULEATUS (vol. II, p. 306).

"GLAUCUS, bien des ichthyologues donnent ce nom à trois sortes de poissons, 1 au Derbio, 2 au Liche, 3 au véritable GLAUCUS," etc. (vol. II, p. 512).

"HARENG, HALEC, Les harengs sont des poissons de passage," etc. (vol. II, p. 610).

"TORPILLE, TORPEDO OU TREMBLE, TORPEDO POISSON," etc. (p. 458).

"GRAPPE MARINE, UVA MARINA."

These are plainly not scientific names. While the writer evidently grasps more or less clearly the meaning of genus and species, he has no conception of binomial nomenclature, as distinct from Latin equivalents of the vernacular names in French. Thus no one would take "PISCIS ACULEATUS" as a generic and specific name for the stickleback or UVA MARINA for the Alga (SARGASSUM) known as Sea-Grape. Further along (Edition II) occurs "POISSON PÉTRIFIÉE" indicated as "Ichthyolithus," which certainly is not the name of any genus. No scientific names, generic or specific, can be held to bear date from this first edition, 1764, of the dictionary of Valmont de Bomare.

"NOUVELLE ÉDITION," 1768, and "ÉDITION II," 1775.

The "Nouvelle édition," dated 1768, is the one examined by Mr. Garman. Except for the paging it seems substantially identical with the edition of 1775, formally called the "second." It has a few binomial terms, mostly among the sharks. The use of Latin equivalents for the French vernacular is still continued, but these assume more frequently a binomial form, especially in the rather elaborate index. The first edition (octavo) contains no index.

In the editions of 1768 and 1775 the only new names to be considered are GALEUS, MUSTELUS, VULPECULA, and CATULUS.

On page 116 (Edition II) we read:

"CAGNOT BLEU, GALEUS GLAUCUS, Grand poisson cartilagineux de la famille des chiens de mer." Then follows a fair account of the Great Blue Shark (SQUALUS GLAUCUS L.; PRIONACE GLAUCA of recent writers), taken from the description of the "Chien de mer bleu" of Rondelet (*de Piscibus*, 1558, p. 296). Rondelet begins "GALEUS GLAUCUS, en Languedoc, CAGNOT BLEU, poisson cartilagineux," etc. He uses the name "Chien de mer," or GALEUS in a general sense, including the "Aiguillat" (ACANTHIAS), the Emissole, ("GALEUS LÆVIS"), the "Chien de Mer Étoilé, GALEUS ASTERIAS," the "Mélandre, GALEUS CANIS," and the "Chien de Mer bleu, GALEUS GLAUCUS."

The other sharks are treated under different heads by Valmont. The entire arrangement appears in the index to the same volume.

"Cagnot bleu, GALEUS GLAUCUS," does not appear in the Fourth Edition (1791).

On page cxxxvii "MUSTELLUS" is defined:

"Espèce de Chien de mer, c'est le GALEUS STELLATUS des auteurs."

The name SQUALUS MUSTELUS L. was mostly based on Artedi's references to the "Émissole" or unspotted dog-fish, the GALEUS LÆVIS of Rondelet and Valmont. The specific name MUSTELUS should remain with that species. On the "LÆVIS" the name MUSTELUS of Linck in 1790 was clearly based. The same species, the "Émissole Commune," is clearly the type of MUSTELUS Cuvier (1817). But if the name MUSTELUS Valmont be accepted, its type must be the dog-fish with round spots, SQUALUS STELLATUS of Risso, MUSTELUS ASTERIAS Valmont.

On page ccxxii of the Index occurs the name "Renard Marin, VULPECULA MARINA." This is apparently borrowed from Willughby and it refers to ALOPIAS VULPINUS, the "Sea Fox" of modern authors. The name is not a "scientific" term, but merely a Latin rendering of the vernacular.

CATULUS rests on CATULUS VULGARIS, which is SCYLLIORHINUS CANICULA L. But the name is not available in any case, being preoccupied by CATULUS Kniphof, a genus of insects.

In the fourth edition (1791) Valmont gives a list of the genera of fishes. All those of Linnæus (1766) are enumerated, but no others and none of his own names are included in the list. Evidently he did not regard himself as having made additions to scientific nomenclature.

The eligibility of Valmont's names is questioned as binomial only by accident, and not accepted as genera by the author himself in 1791.

Galeus Valmont de Bomare, I, 371, 1768; type SQUALUS GLAUCUS L.

"CAGNOT BLEU, GALEUS GLAUCUS," with description.

If regarded as eligible GALEUS will replace PRIONACE and CYNOCEPHALUS.

Vulpecula Valmont de Bomare, III, 740, 1768; type VULPECULA MARINA Valmont = SQUALUS VULPINUS Bonnaterre = SQUALUS VULPES Gmelin.

"VULPECULA MARINA; RENARD MARIN," with description.

If eligible, VULPECULA will replace ALOPIAS Rafinesque, 1810.

Catulus Valmont de Bomare, IV, 51, 1768; type SQUALUS CANICULUS L. (CATULUS MAJOR VULGARIS Ray).

According to Sherborne, *Index Animalium*, it is preoccupied by CATULUS Kniphof, *De. Pedic.*, p. 16, 1759, a genus of insects. Equivalent to SCYLLIORHINUS Blainville.

Mustelus Valmont de Bomare, Ed. II, 746, 1768, and Ed. III, 1775, lxxxi; type GALEUS ASTERIAS Valmont = MUSTELUS CANIS Mitchill, 1815 = MUSTELUS STELLATUS Risso, 1826.

"Galeus asterias aut Mustelus stellaris. Chien de mer à taches rondes."

XIII. GOUAN, *Historia Piscium*, 1770.

ANTOINE GOUAN.

Trachipterus Gouan, 104; type TRACHIPTERUS GOUANI = CEPOLA TRACHYPTERA Gmelin.

Lepadogaster Gouan, 105; type LEPADOGASTER GOUANI Gouan.

Lepidopus Gouan, 107; type LEPIDOPUS GOUANI Gouan (TRICHIURUS CAUDATUS Euphrasen).

XIV. KŒLREUTER, *Piscium Rarorum;* Novi Comm. Act. Petropolit. VIII, 1770.

JOSEPH GOTTLIEB KŒLREUTER.

Mola Kœlreuter, 337; type MOLA ACULEATA Kœlreuter.
Antedates MOLA Cuvier.

XV. FORSTER, *Catalogue of Animals of North America*, 1771.

JOHN REINHOLD FORSTER.

Remora Forster, 20; type ECHENEIS REMORA L.
Equivalent to REMORA of Catesby and of Gill.

XVI. BRÜNNICH, *Collectio Nova Scriptorum Societatis Scientiarum Hafnensis*, 1771.

M. T. BRÜNNICH.

Regalecus Brünnich, III, 418; type REGALECUS REMIPES Brünnich (OPHIDIUM GLESNE Ascanius).
Also described in 1788.

XVII. CATESBY AND EDWARDS, *Natural History of Carolina, Florida and the Bahama Islands*, 1731-1750, by MARK CATESBY; Edition Second, 1771, by GEORGE EDWARDS.

The large folio volume in which Mark Catesby published the record of his visit to the Bahamas and other parts of America has had an important place in the history of American Ichthyology. Numerous editions of this work with the same plates have been published in German, French and English.

Two of these, the Edwards' Edition of 1771, and the edition quoted as "Catesby, Pisc. Imag., Etc., in 1777," are subsequent to Linnæus and may perhaps deserve consideration in nomenclature, although apparently not eligible in view of Opinion 57, which regards the post-Linnæan translation of Hasselquist as ineligible. These editions contain tables showing the Linnæan names of Catesby's species. Except as an evidence of "revision," these have no bearing on Catesby's "genera." If the generic names with polynomial specific names, of Gronow, Klein, and others are accepted, we can hardly refuse notice to the Latin nouns used by Catesby as republished by Edwards. These nouns have the force of genera, and being built about actual specimens they are mostly monotypic; while those of Gronow and Klein are subdivisions of a system, each covering as a rule many species. The names of Catesby are listed as genera in Sherborne's *Index Animalium* by an author who is rather critical of Latin vernaculars. But Catesby wrote before Artedi and Linnæus had framed the idea of a genus. He was not therefore consciously engaged in the differentiation of generic groups. He was not, to borrow a phrase from Mr. Stejneger, "playing the game." For this reason it seems to us that his names should not be admitted to the system. It is, however, very important to have a decision once for all in this matter.

The names in Edwards' Catesby are of doubtful eligibility as being Latin vernacular nouns rather than genera, and as a reprint virtually unchanged of a pre-Linnæan work.

Umbla Catesby, 1; type ESOX BARRACUDA Shaw (SPHYRÆNA PICUDA Bloch & Schneider). "UMBLA MINOR, MAXIMA MAXILLIS LONGIORIBUS, the Barracuda" Catesby.

Equivalent to SPHYRÆNA and prior to it, if accepted in the system.

Mormyrus Catesby, 2; type ULÆMA LEFROYI (Goode). "MORMYRUS EX CINEREO NIGRICANS, the Bone-fish" Catesby.

Identification somewhat uncertain. The name in any event is subsequent to MORMYRUS L.

Saurus Catesby, 2; type SALMO FŒTENS L. "SAURUS EX CINEREO NIGRICANS, the Sea Sparrow Hawk" Catesby.

Identical with SYNODUS Gronow, 1763.

Albula Catesby, 6; type MUGIL CUREMA Cuv. & Val. ("ALBULA BAHAMENSIS Catesby).

A synonym of MUGIL L., subsequent to ALBULA Gronow, 1763, and ALBULA Osbeck, 1761.

Hirundo Catesby, 8; type CYPSELURUS sp., "HIRUNDO" Catesby.

Not HIRUNDO L., 1758, a genus of Swallows.

Turdus Catesby, 9; type LUTIANUS GRISEUS (L.) "TURDUS PINNIS BRANCHIALIBUS CARENS, the Mangrove Snapper" Catesby.

Not TURDUS, 1758, a genus of Thrushes.

Alburnus Catesby, 12; type CYPRINUS AMERICANUS L. = MENTICIRRUS AMERICANUS. "ALBURNUS AMERICANUS, the Carolina Whiting" Catesby, type of CYPRINUS AMERICANUS L., *Syst. Nat.*, X, 321.

If accepted, the genus ALBURNUS must replace MENTICIRRUS Gill, and the genus of CYPRINIDÆ called ALBURNUS by Rafinesque and Agassiz must receive another name.

Cugupuguacu Catesby, 14; refers to EPINEPHELUS MACULOSUS (Cuv. & Val.). ("CUGUPUGUACU BRAZIL, the Hind" Catesby).

Catesby's fish is not that called CUGUPUGUACU by Marcgrave. If this barbarous name be allowed it will replace EPINEPHELUS. But it is evident that CUGUPUGUACU, PETIMBUABO and ACARAUNA are not in any sense generic names, but attempts on the part of Catesby to identify his species with those called in Brazil by these vernacular names. In the case of ACARAUNA, Catesby is himself doubtful. Even in case names used in an actual generic sense, as UMBLA, AURATA, UNICORNIS were allowed, CUGUPUGUACU and ACARAUNA should be rejected.

Saltatrix Catesby, 14; type GASTEROSTEUS SALTATRIX L., which is based on Catesby's figure, ("SALTATRIX, the Skipjack").

If allowed, will replace POMATOMUS Lacepède, 1802.

Suillus Catesby, 15; type LACHNOLAIMUS SUILLUS Cuvier, "SUILLUS" Catesby, based on Catesby's figure.

If allowed, SUILLUS will replace LACHNOLAIMUS Cuvier.

Aurata Catesby, 16; type CALAMUS CALAMUS (Cuv. & Val.). "AURATA BAHAMENSIS, the Porgy," Catesby.

Not AURATA Fleming, 1828, which is SPARUS L. If allowed, AURATA will replace CALAMUS Swainson.

Salpa Catesby, 17; type SPARUS SYNAGRIS L. (LUTIANUS SYNAGRIS, based on "SALPA PURPURASCENS VARIEGATA, the Lane Snapper," Catesby.

Prior to SALPA Forskål, 1775. If allowed, SALPA would replace NEOMÆNIS or LUTIANUS and perhaps add further to the confusion among the Salpoid Tunicates, although it is claimed that an earlier name, DAGYSA, must replace SALPA Forskål.

Novacula Catesby, 18; type SCARUS CÆRULEUS Bloch. "NOVACULA CÆRULEA, the Blue-fish," Catesby.

Name a synonym of CALLYODON Gronow, but prior to NOVACULA Cuvier, which is a synonym of XYRICHTHYS Cuvier.

Petimbuabo Catesby & Edwards, 18; refers to FISTULARIA TABACARIA L. "PETIMBUABO BRAZIL, the Tobacco Pipe-fish," Catesby.

A synonym of FISTULARIA L., but obviously not intended as a generic name.

Unicornis Catesby, 19; type OSBECKIA SCRIPTA (Osbeck). "UNICORNIS PISCIS BAHAMENSIS, the Bahama Unicorn-fish," Catesby.

If accepted, would replace OSBECKIA Jordan & Evermann.

Bagre Catesby, 23; type SILURUS CATUS L. (AMEIURUS CATUS L.) "BAGRE SECUNDÆ SPECIEI MARCGRAVEI AFFINIS, the Cat-fish," Catesby.

If accepted, BAGRE must replace AMEIURUS.

Harengus Catesby, 24; type CLUPEA SARDINA Poey. "HARENGUS MINOR BAHAMENSIS, the Pilchard," Catesby.

Equivalent to HARENGULA Cuv. & Val., and, if allowed, would replace the latter.

Anthea Catesby, 25; refers to MESOPRION ANALIS Cuv. & Val. A species of NEOMÆNIS, Girard. "ANTHEA QUARTUS RONDELETI, the Mutton-fish," Catesby.

Not intended as a generic name, being wrongly identified with the fourth ANTHIA of Rondelet.

Remora Catesby, 26; type ECHENEIS REMORA L. "REMORA, the Sucking-fish," Catesby.

Equivalent to REMORA Forster, and of Gill.

Solea Catesby, 27; type PLEURONECTES LUNATUS L., based on Catesby's figure. "SOLEA LUNATA ET PUNCTATA, the Sole," Catesby.

Not SOLEA of Klein nor of subsequent writers. If allowed, SOLEA would replace PLATOPHRYS; and SOLEA of Klein, Quensel, Rafinesque and Cuvier would require a new name.

Orbis Catesby & Edwards, 28; type TETRAODON TESTUDINEUS L. "ORBIS LÆVIS VARIEGATUS, the Globe-fish," Catesby.

A synonym of TETRAODON L.

Psittacus Catesby, 29; type LABRUS CATESBÆI Lacepède. "PSITTACUS PISCIS VIRIDIS BAHAMENSIS, the Parrot-fish," Catesby.

Not PSITTACUS L., 1758, a genus of parrots.

Acus Catesby, 30; type ESOX OSSEUS L. "ACUS MAXIMA SQUAMOSA VIRIDIS, the Green Gar-fish," Catesby.

Equivalent to PSALISOSTOMUS Klein and LEPISOSTEUS Lacepède.

Acarauna Catesby, 31; refers to HOLACANTHUS CILARIS L. "AN ACARAUNA MAJOR PINNIS CORNUTIS AN PARU BRASILIENSIBUS?, the Angel-fish," Catesby.

This name cannot be used to replace HOLACANTHUS as it represents a very doubtful identification on the part of Catesby; not at all a generic division.

Vipera Catesby, 9, Appendix; refers to VIPERA MARINA Catesby (CHAULIODUS SLOANI Bloch & Schneider).

As it is a fish, it cannot belong to the genus VIPERA L. VIPERA MARINA is apparently merely a vernacular name, sea-viper or viper-fish being intended.

Cataphractus Catesby, 9, Appendix; type SILURUS CATAPHRACTUS L. = DORAS CATAPHRACTUS of authors = CATAPHRACTUS AMERICANUS Catesby.

This name, being preoccupied, cannot replace DORAS Lacepède.

XVIII. GÜLDENSTADT, *Acerina piscis ad Percæ genus pertinens:* Nov. Comm. Acad. Petropol., 1774, XIX.

ANTON JOHANN VON GÜLDENSTADT.

Not seen by us.

Acerina Güldenstadt, 455; type PERCA CERNUA L. (ACERINA KABIR Güldenstadt).

Equivalent to CERNUA Schæfer.

XIX. *Descriptiones Animalium quæ in Itinere Orientali Observavit,* by PETRUS FORSKÅL (edited after the death of the author by CARSTEN NIEBUHR). 1775.

Siganus Forskål, X; type SCARUS RIVULATUS Forskål.

No definition. This genus has been of late years generally called TEUTHIS, but apparently this Linnæan name should remain with the group for which Browne first used it.

Torpedo Forskål, 1775, 16; type RAJA TORPEDO (not of Linnæus) = SILURUS ELECTRICUS Gmelin, MALAPTERURUS ELECTRICUS Lacepède.

Forskål describes the Electric Cat-fish of the Nile under the erroneous name of RAJA TORPEDO L. He questions whether it might be allied to MORMYRUS or whether it might find a place among the torpedoes of Rondelet, or might it be type of a new genus. "Aut potius novum constituere genus. Certe determinatur torpedinis CHARACTER GENERICUS: Piscis branchiostegus: apertura lineari, obliqua supra pinnæ pectorales; corpore nudo: pinnis ventralibus seu abdominalibus; dentibus numerosissimis densis, subulatis." This statement leaves no question as

to the species in mind, but TORPEDO Houttuyn, 1764, if available, is of still earlier date.

Salaria Forskål, X and 22; type (without specific name) = BLENNIUS BASILISCUS L.

The genus is equivalent to BLENNIUS L. Not SALARIAS Cuvier.

Scarus Forskål, 25; type SCARUS PSITTACUS Forskål.

The type no doubt intended was LABRUS SCARUS L., of the Mediterranean "antiquo nomine σκάρος"; but that species was not mentioned by Forskål, and another must be taken as the type. The name SCARUS was earlier used by Gronow as a synonym of LABRUS. SCARUS of Forskål must give way to CALLYODON of Gronow if the names of Gronow are to be adopted. This is unfortunate, as CALLYODON has been used by most authors as the name of another genus in the same family.

Abu-defduf Forskål, 59; type CHÆTODON SORDIDUS Forskål.

Equivalent to the later GLYPHISODON of Lacepède, 1803. The definition of this genus admits of no question. It occurs in the same paragraph with the equally accurate definition of ACANTHURUS. It may receive objection as a barbarous name. It was probably a "stop-gap" word for which Forskål intended to supply a Latin equivalent. This his editor after his death failed to do and we must apparently take it as it stands: "A generic name is a name without necessary meaning." (*Baird.*)

Acanthurus Forskål, 59; type CHÆTODON SOHAL Forskål; to be replaced by HEPATUS Gronow, if Gronow's names are adopted; otherwise by TEUTHIS L.

Later restricted by authors to the first species named. CH. UNICORNIS.

Besides these names, clearly eligible, Forskål lists a number of subordinate groups or subgenera, under PERCA, SCARUS and SCIÆNA. Some of these are properly and fully defined, and would be accepted without question if in Latin. But all are in Arabic, and may perhaps be taken as vernacular words, as one might divide a genus into "Groupers," "Snappers" and "Porgies." We may perhaps reject them on the same ground as that on which we reject "les sphéroides."

In addition to these more or less formal names are two sections, one under SCARUS called "dentibus Abudjubbe," equivalent to CHEILINUS Lac., and one "dentibus Harid," equivalent to SCARUS. LOUTI and DABA are above reproach, except as to their Arabic origin. ABUHAMRUR is defined by reference to its type species. NAQUA is based on a species referred with doubt to SCIÆNA. GHANAN, SCHOUR and TAHHMEL are names only, identifiable by the correspondence with the Arabic names of their type species.

These names of Forskål doubtfully eligible, being vernacular and not meant as subgeneric.

Naqua Forskål, xvii; type SCIÆNA GIBBA Forskål.

With definition as "Piscis marinis rubri obscuris, an Sciæna 48?" Equivalent to GENYOROGE Cantor, 1850.

Louti Forskål, 44; type PERCA LOUTI Forskål.

With full definition. Equivalent to VARIOLA Swainson, 1839, which apparently it should replace.

Daba Forskål, 44; type PERCA AREOLATA Forskål.

With full definition. EPINEPHELUS Bloch, 1798, which apparently it should replace.

Abuhamrur Forskål, 44; type SCIÆNA HAMRUR Forskål.

With definition by reference to the type species. PRIACANTHUS Cuvier, 1817.

Hobar Forskål, 44; type SCIÆNA BOHAR Forskål.

With short definition. LUTIANUS Bloch, 1790.

Farer Forskål, 44; type SCIÆNA SAMMARA Forskål.

With definition. HOLOCENTRUS Gronow, 1763.

Ghanan Forskål, 44; type SCIÆNA GHANAM Forskål.

Without definition. SCOLOPSIS Cuvier, 1817.

Djabub Forskål, 44; type SCIÆNA JARBUA Forskål.

With definition. THERAPON Cuvier, 1817.

Gaterin Forskål, 44; type SCIÆNA GATERINA Forskål.

With scanty definition. PLECTORHINCHUS Lacepède, 1800.

Schour Forskål, 44; type SCIÆNA NEBULOSA Forskål.

Without definition. LETHRINUS Cuvier, 1817.

Tahhmel Forskål, 44; type SCIÆNA TAHHMEL Forskål.

Without definition. KYPHOSUS Lacepède, 1800, subgenus OPISTHISTIUS Gill, 1862.

XX. KLEIN, *Neuer Schauplatz der Natur, nach den Richtigsten Beobachtungen und Versuchen, in Alphabetischer Ordnung.*

Durch eine Gesellschaft der Gelehrten. Weidmann, Leipzig. (Quoted as "Gesellschaft Schauplatz.")

No author named, the account of the fishes compiled from ***Historia Piscium Naturalis*** Klein, perhaps by Philip Ludwig Statius Müller, professor at Erlangen. Vol. I, 1775; vol. II, 1776; vol. III, 1776; vol. IV, 1777; vol. V, 1777; vol. VI, 1778; vol. VII, 1779; vol. VIII, 1779; vol. X, 1781.

JAKOB THEODOR KLEIN.

In a recent monograph of the sharks and rays (PLAGIOSTOMIA: Mem. Mus. Comp. Zool., Harvard College, XXXVI, 1916) Mr. Samuel Garman calls attention to the availability in nomenclature of names of genera accepted from Klein, a pre-Linnæan writer, in a post-Linnæan dictionary called "Neuer Schauplatz," or for convenience "Gesellschaft Schauplatz." This publication began, according to Mr. Garman, as a translation of Valmont de Bomare, but later it was extended and improved.

We find no copy of this work in the libraries of Washington and New York. It is probable that the copy in Mr. Garman's possession, which its owner has kindly placed at our disposal, is the only one now in the United States.

Mr. Garman remarks: "The Schauplatz referred to above is anonymous, it is true, but it gives the authorities for its generic and specific names, and thus its citations amount to republication after 1758, by the original authors, previous as the first publication may have been."

All the generic names used by Jacob Theodor Klein in his *Historia Piscium Naturalis,* 1740 to 1744, are here reproduced and accepted, thus bringing them for consideration into eligibility in scientific nomenclature. If accepted they therefore replace nearly all competing names except those of Artedi (1738) accepted by Linnæus (1758), and those of Gronow (1763).

Toward the middle of the eighteenth century the idea of genus among animals as a basis of classification became common property among naturalists. The name of the genus was recognized as consisting of a single word, but, until 1758, the species was indicated by a descriptive phrase attached to the name of the genus. By the device of binomial nomenclature, Linnæus made the system coherent, allotting to genus and species each a single word, the first a noun, the second of the nature of an adjective or genitive. In zoology, scientific nomenclature therefore dates from January 1, 1758, the time of the development of this system by Linnæus in the Tenth Edition of his *Systema Naturæ.*

Prior to Linnæus, on the basis of definite genera with polynomial species, three distinguished ichthyologists had separately developed, without knowledge of each other's work, a system of classification of fishes. These were Peter Artedi, "the Father of Ichthyology," in Upsala, in 1738; Jacob Theodor Klein, in Jena, 1740 to 1744; and Lorenz Theodor Gronow, in Leyden, 1754 to 1780. Of these authors the work of Artedi was the most compact and accurate, that of Klein the most elaborate, and that of Gronow based on the most material. Artedi's work was the basis of Linnæus's classification of the fishes. The principal part of the work

of Gronow was published in 1763. His names have been accepted as eligible by the International Commission of Zoological Nomenclature.

In this paper we give a list of these genera of Klein together with the Linnæan type, each as understood or as indicated by the present writer. In deciding on the type, the writer has been materially aided by the possession of a copy of Klein's *Historia Piscium Naturalis*, which was once the property of his commentator, Dr. Johann Julius Walbaum of Greifswald, and which contains profuse annotations in Walbaum's own handwriting.

Dr. Walbaum himself published in 1792 (*Petri Artedi sueci Genera Piscium*, 589-587) a classified record of the genera of Klein, but without actually accepting these as part of the System. Later Walbaum printed an Index to all these early names of various authors, as *Ichthyologia Enodata sive Index Rerum* (Leipzig, 1793). In this Index the generic and other names used by previous writers are arranged in alphabetical order with indication of the Linnæan synonymy. This again does not, in the view of the Zoological Commission (Opinion 21), involve the acceptance of any of these names. A reprint of Klein's *Historiæ Piscium Naturalis* was published, with notes by Walbaum, in 1802.

In the *Gesellschaft Schauplatz* Klein's names are frankly adopted, and the chief serious objection to be raised is that the species are named polynomially. We here omit those names in the *Schauplatz*, as ACIPENSER, CYPRINUS, XIPHIAS, etc., which had been used by Linnæus and were already accepted in the System with the same significance. We are indebted to Mr. Garman for the verification of the list and for the insertion of page references.

Illustrations of the method of the elliptical and disorderly *Schauplatz* are the following. In vol. I, p. 918, 1777, we read:

"Botte. RHOMBUS, ein Kleinisches Fischgeschlecht, welches Linné, PLEURONECTES G. 163, Müller Seitenschwimmer, Richter Butten nennt," etc. Description follows.

In III, p. 512, we find: "GREETE, Kleinische, eine Art platteise, Butten, Richter: s(iehe) Botte, RHOMBUS, des Kleins und unsern Artikel Th. I, s. 918; desgleichen Flunder, PASSER 4 des Kleins und unsern Artikel Th. III, s. 151" etc.

"PASSER 4" is the species called "PASSER ASPER S(EU), SQUAMOSUS Rondelet. This species is PLEURONECTES LIMANDA L. With (eight) other species named polynomially, it is set forth in the *Schauplatz*, after Klein. The quotations from Müller probably refer to the Nürnberg Edition of the *Systema Naturæ*, published in German by Professor Philip

Ludwig Statius Müller of Erlangen, in 1776. This edition in its Supplement contains a few new specific names but no new genera, so far as noticed.*

The reference to "Richter," refers apparently to a work published at Leipzig, in 1754, by J. G. O. Richter, entitled *"Ichthyotheologie, oder Versuch die Menschen aus Betrachtung der Fische zu Bewunderung des Schöpfers zu führen."* This we have not seen, but quote the title from Bosgoed. The same work appears in Dutch, in 1768, as *"Godleerende Vischkunde."*

The names in the "Gesellschaft Schauplatz" are all of doubtful eligibility, because not adopting the Linnæan Code as to species, and possibly because published in an anonymous dictionary.

Conger Klein, I, 22, 1775; type MURÆNA CONGER L. "CONGER PINNA MEMBRANACEA" Klein.

A synonym of CONGER Houttuyn.

Enchelyopus Klein, I, 32, 1775; type TRICHIURUS LEPTURUS L. "ENCHELYOPUS CAPITE PRODUCTO SERPENTINO" Klein.

A synonym of TRICHIURUS L., not ENCHELYOPUS Gronow.

Brama Klein, I, 61, 932, 1775; type CYPRINUS BRAMA L. "BRAMA PRIMI RADIO PINNÆ DORSALIS SIMPLICI" Klein.

BRAMA, if accepted, replaces ABRAMIS Cuvier, and the marine genus now called BRAMA would take the name of LEPODUS Rafinesque.

Galeus Klein, I, 70, 1775; type SQUALUS GALEUS L. "GALEUS ROSTRI EXTREMA PARTE PELLUCIDA" Klein.

Equivalent to GALEORHINUS Blainville, 1816 = GALEUS Cuvier, 1817, not GALEUS Valmont, 1768, nor of Rafinesque, 1810.

Trutta Klein, I, 115, 1775; type SALMO TRUTTA L. "TRUTTA TOTA ARGENTEA" Klein.

A synonym of TRUTTÆ L.

Leuciscus Klein, I, 172, 1775; type CYPRINUS LEUCISCUS L. "LEUCISCUS SUPRA LINEA LATERALIS" Klein.

LEUCISCUS Klein would replace LEUCISCUS Cuvier, Rafinesque, Agassiz, for the same group.

Pelamys Klein, I, 176, 1775; type SCOMBER SCOMBRUS L. "PELAMYS CORPORE CASTIGATO" Klein, the "makarel" of Willughby.

The genus, based on the tunnies and the mackerels, is exactly coterminous with SCOMBER L. If regarded as eligible, the genus of snakes, PELAMYS Daudin, must receive a new name.

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*See "On the Fishes Described in Müller's Supplemental Volume to the *Systema Naturæ* of Linnæus," D. S. Jordan, Proc. Acad. Nat. Sci., 1890, p. 48.

Harengus Klein, I, 209, 1775; type CLUPEA HARENGUS L. "HARENGUS VULGARIS" Klein.

Synonym of CLUPEA L.

Amphisilen Klein, I, 280, 1775; type CENTRISCUS SCUTATUS L. "AMPHISILEN" Klein.

Monotypic. A synonym of CENTRISCUS L., and AMPHISILE Cuvier.

Latargus Klein (misprint for LATHARGUS), I, 298, 1775; type ANARHICAS LUPUS L. "LATARGUS ROSTRO RETUSO DENTIS HORRIDIS" Klein.

Synonym of ANARHICHAS L. Monotypic.

Leiobatus Klein, I, 316, 1775; type RAJA OXYRHYNCHUS L. "LEIOBATUS ROSTRO OMNIUM LONGISSIME PRODUCTO" Klein.

Synonym of RAJA L. Includes all smooth rays.

Synagris Klein, I, 442, 1775; type SPARUS AURATA L. "SYNAGRIS DORSO OBSCURE VIRIDE" Klein.

A synonym of SPARUS L. Includes many sparoid fishes.

Mystus Klein, I, 535, 1775; type "MYSTUS FLUVIATILIS" Klein = CYPRINUS BARBUS L., not MYSTUS Gronow, 1763.

Equivalent to BARBUS Cuvier.

Passer Klein, I, 816, 1775; type PLEURONECTES FLESUS L. "PASSER CUTE DENSIS TUBERCULIS."

Not of Brisson, 1760, a genus of birds. A synonym of FLESUS Moreau.

Glaucus Klein, I, 829, 1775; type SCOMBER GLAUCUS L. "GLAUCUS ACULEATUS MACULIS IN UTROQUE LATERE" Klein.

GLAUCUS, if allowable, replaces CÆSIOMORUS Lacepède, a genus distinct from TRACHINOTUS Lacepède, 1803. HYPODIS Rafinesque, 1810, is the same.

Rhombus Klein, I, 918, 1775, VIII, 88, 1779; type PLEURONECTES RHOMBUS L. "RHOMBUS OMNIUM MINIMUS PALMÆ LONGITUDINE."

This name antedates RHOMBUS Da Costa, 1776, a genus of Snails. If eligible, it replaces BOTHUS Rafinesque, and is equivalent to RHOMBUS Cuvier, 1817. The other nominal species of RHOMBUS are synonyms of the Turbot, PSETTA MAXIMA (L.).

Rhombotides Klein, I, 922, 1775; type CHÆTODON CÆRULEUS Bloch. "RHOMBOTIDES OBSCURE CÆRULEUS" Klein, after Catesby.

Synonym of ACANTHURUS Forskål, and of TEUTHIS of Browne and Linnæus, Klein suggests as substitute names, if RHOMBOTIDES is not acceptable, EUROPUS and PSETTA.

Sargus Klein, I, 966, 1775; type SPARUS SARGUS L. "SARGUS PINNIS VENTRALIBUS" Klein.

SARGUS, if allowed, replaces DIPLODUS Rafinesque, and SARGUS Cuvier. The genus of Insects called SARGUS would in this case require a new name.

Dasybatus Klein, I, 991, 1775; type RAJA PASTINACA L. "DASYBATUS CAUDA SQUAMEIS OSSEIS" Klein.

DASYBATUS, if allowed, replaces DASYATIS Rafinesque and TRYGON Adanson. Intended to include all the rough-skinned rays.

Prochilus Klein, I, 1043, 1775; type, as here restricted, "PROCHILUS LÆVIS LATERIBUS CARINATUS" Klein (BLENNIUS PHOLIS L.).

Equivalent to PHOLIS Cuv. & Val., a name used earlier for another genus by Gronow and Scopoli. In this sense PROCHILUS is a subgenus under BLENNIUS. ..

On plates in Bleeker's Atlas, PROCHILUS is used instead of AMPHIPRION, the species named first by Klein being AMPHIPRION EPHIPPIUM (Bloch). We find, however, no formal restriction of PROCHILUS by Bleeker.

Labrax Klein, II, 32, 1775, and VIII, 164, 1779; type PERCA LABRAX L. "LABRAX SIVE LUPUS" Klein.

LABRAX, if allowed, replaces DICENTRARCHUS Gill = LABRAX Cuvier, 1817. Not LABRAX of Pallas, 1810, which is HEXAGRAMMOS.

Percis Klein, II, 45, Ed. 2, 1776; type PERCA CERNUA L., as restricted by Bleeker, *Systema Percarum Revisum*. "PERCIS PINNIS SEX ANTERIORE PARTE DORSALIS 14" Klein.

Equivalent to CERNUA Schæfer 1761, GYMNOCEPHALUS Bloch & Schneider 1801, to ACERINA Cuvier 1817, and CERNUA Fleming 1828; not PERCIS Scopoli 1777, nor of Cuvier.

Narcacion Klein, II, 237, 1776; IV, 726, 1777; type RAJA TORPEDO L. "NARCACION DEMTA CAUDA SINUOSA CIRCULARIS" Klein.

NARCACION, if accepted, replaces TORPEDO Duméril, not of Forskål. If rejected, NARCOBATUS Blainville is next in date. Monotypic.

Mænas Klein, II, 360, 1776; type SPARUS MÆNA L. "MÆNAS DILUTE VIRIDIS" Klein.

MÆNAS would replace MÆNA Cuvier.

Cicla Klein, II, 412, 1776; type LABRUS VIRIDIS L. "CICLA VIRIDIS OPERCULORUM" Klein.

Synonym of LABRUS L. Comprises all the species of LABRUS L., called TURDUS or MERULA by authors, these names also signifying "thrush." If accepted, CICHLA Bloch & Schneider, 1801, would require a new name.

Rhina Klein, II, 587, 1776; type RHINA SQUATINA L. "RHINA SIVE SQUATINA" Klein.

RHINA, if allowed, replaces SQUATINA Duméril.

Rhinobatus Klein, II, 593, 1776; type RAJA RHINOBATUS L. "RHINOBATUS SEU SQUATINO RAJA" Klein.

RHINOBATUS would replace RHINOBATUS Bloch & Schneider, 1801, and SYRRHINA Müller & Henle, based on the same species.

Solea Klein, III, 115, 1776; type PLEURONECTES SOLEA L. "SOLEA SQUAMIS MINUTIS" Klein.

SOLEA Klein would replace SOLEA Rafinesque, SOLEA Quensel and SOLEA Cuvier.

Pseudopterus Klein, III, 139, 1776; type GASTEROSTEUS VOLITANS L. "PSEUDOPTERUS QUI PERCA AMBOINENSIS" Klein.

Replaces, if allowed, PTEROIS Cuvier.

Tetragonoptrus Klein, III, 153, 1776; type CHÆTODON CAPISTRATUS L. "TETRAGONOPTRUS LÆVIS AD CAUDAM BRUNNEA" Klein.

Synonym of CHÆTODON L. Bleeker uses this name in place of CHÆTODON, as Artedi's "type" of CHÆTODON—that is, the species first named—is a POMACANTHUS. But Artedi included also true species of CHÆTODON in his list, and the name was adopted by Linnæus from his own use of it, in the *Amœnitates Academiciæ*.

Batrachus Klein, III, 202, 1776; type LOPHIUS PISCATORIUS L. "BATRACHUS RICTUQUE RANÆ" Klein.

Synonym of LOPHIUS L., not BATRACHUS Bloch & Schneider, 1801.

Mastaccembelus Klein, III, 271, 1776; type ESOX BELONE L. "MASTACCEMBELUS MANDIBULIS LONGISSIMIS" Klein.

Not MASTACEMBELUS Gronow, 1763; stands as BELONE Cuvier.

Platiglossus Klein, III, 300, 1776; type HALICHŒRES MARGINATUS Rüppell. "PLATIGLOSSUS SUBRUFUS SQUAMULIS LÆVIBUS" Klein.

Accepted by Bleeker as PLATYGLOSSUS. Klein's figure is crude, but recognizable.

Lucius Klein, III, 506, 1776; type ESOX LUCIUS L. "LUCIUS . . . ROSTRO QUASI ANSERINO" Klein.

Synonym of ESOX L. = LUCIUS Rafinesque.

Cestracion Klein, III, 523, 1776; type SQUALUS ZYGÆNA L. "CESTRACION FRONTE ACUS" Klein.

CESTRACION, if accepted, replaces SPHYRNA Rafinesque and ZYGÆNA Cuvier. CESTRACION Cuvier is a different genus, HETERODONTUS Blainville, CENTRACION Gray.

Trichidion Klein, III, 592, 1776; type POLYNEMUS VIRGINICUS L. "TRICHIDION CORPORE OBLONGO" Klein.

A synonym of POLYNEMUS L. as restricted by authors generally. Monotypic.

Asperulus Klein, III, 686, 1776; X, 236, 1781; type PERCA ZINGEL L. "ASPERULUS VEL ASPREDO DORSO ACUTO" Klein.

Identical with ZINGEL Oken. Monotypic.

Corystion Klein, III, 762, 1776; type TRIGLA LAPPONICA L. "CORYSTION CORPORE GRANULATO" Klein.
A synonym of TRIGLA L.

In volume III of the *Gesellschaft Schauplatz,* 1776, pp. 61-73, is given a list of the genera of fishes. This includes so far as we note all those proposed by Klein and those of Linnæus also, those of Klein appearing first. The names are not in alphabetical order, but follow the sequence of Klein's *Historia Piscum Naturalis.* This seems to imply a post-Linnæan acceptance of all of Klein's genera, even were their use in the text rejected. One new name appears:

Pristis Klein, III, 61, 1776; type "PRISTIS, der Sägeschnautz."
Equivalent to PRISTIS Linck.

XXI. SCOPOLI, *Introductio ad Historiam Naturalem,* Prague, 1777.

JOHANN ANTON SCOPOLI.

A descriptive catalogue of the genera of animals and plants. The genera of fishes are mostly those of Linnæus and Gronow. No types are named save in the two new, PERCIS and PTERIDIUM.

The following names given by Gronow are not accepted by Scopoli:

ENCHELYOPUS (regarded as a synonym of BLENNIUS), ELEOTRIS (= GOBIUS), PLECOSTOMUS (= LORICARIA), CORACINUS (= SCIÆNA), CALLORHYNCHUS (= CHIMÆRA), CATAPHRACTUS (= PEGASUS), GYMNOGASTER (= TRICHIURUS), CYCLOGASTER (= LIPARIS), HEPATUS, (= TEUTHIS); AMIA is used only in the Linnæan sense.

Liparis (Artedi) Scopoli, 453; type (not named) CYCLOPTERUS LIPARIS L.

Percis Scopoli, 454; type COTTUS JAPONICUS Pallas.
Equivalent to HIPPOCEPHALUS Swainson, 1839, not PERCIS Klein.

Pteridium Scopoli, 454; type CORYPHÆNA VELIFERA Pallas (PTERACLIS Gronow).

The following names of Gronow are introduced into Linnæan nomenclature by Scopoli, without mention of type. These date from Scopoli, 1777, if the *Zoophylaceum* of Gronow, 1763, be not accepted.

ERYTHRINUS, 449
SYNODUS, 449
CALLYODON, 449
HOLOCENTRUS, 449
(misprinted HOLOCENTHRUS)
GONORHYNCHUS, 450
ALBULA, 450
UMBRA (Krämer), 450
ANABLEPS, 450
ANOSTOMUS, 451
MYSTUS, 451
CALLICHTHYS, 451
ASPREDO, 453
CHARAX, 455
CLARIAS, 455
CYNÆDUS, 455
PHOLIS, 456
MASTACEMBELUS, 458
CHANNA, 459

XXII. FORSTER, *Icones Ineditæ;* Bibliotheca Banksiæ, 1777.

JOHN REINHOLD FORSTER.

Echidna Forster, 181; type ECHIDNA VARIEGATA Forster = MURÆNA ECHIDNA Gmelin.

This generic name, according to Kaup, first appears in 1777, in the *Icones Ineditæ.* It must be retained for the genus of fishes, and is not available for the genus of mammals named ECHIDNA by Cuvier, = TACHYGLOSSUS.

XXIII. KLEIN, *Gesellschaft Schauplatz,* vols. IV, V, 1777.

JAKOB THEODOR KLEIN.

Oncotion Klein, IV, 46, 1777; type CYCLOPTERUS LUMPUS L. "ONCOTION COLORE NIGRICANTE" Klein.

A synonym of CYCLOPTERUS L.

Cynocephalus Klein, IV, 161, 1777; type SQUALUS GLAUCUS L. "CYNOCEPHALUS GLAUCUS" Klein, as restricted by Gill.

CYNOCEPHALUS Boddært is of later date. Equivalent to PRIONACE Cantor.

Callarias Klein, IV, 327, 1777; type GADUS MORRHUA L. "CALLARIAS SORDIDE OLIVACEUS" Klein.

Synonym of GADUS L.

Crayracion Klein, IV, 788, 1777; type TETRAODON SPENGLERI Bloch. "CRAYRACION LÆVISSIMUS EX TERREO RUFESCENS" Klein.

A synonym of TETRAODON L.

The type of this genus was first fixed by Bleeker, *Atlas Ichth.,* 1865, 65. Bleeker observes: "La première espèce du genre compliqué que Klein en 1742 déjà nomma CRAYRACION étant le TETRAODON SPENGLERI des auteurs ou au moins une espèce extrêmement voisine, je propose d' indiquer sous ce nom générique toutes

les espèces à tentacule nasale non perforée. . . . Le nom de CRAYRACION est antérieur de plusieurs années à celui de TETRAODON et devrait être substitué à ce dernier si le type du genre n'était pas reconnu à un genre distincte du CRAYRACION LÆVISSIMUS de Klein."

This fixes the type of Klein on the species figured by him, but Bleeker is in error in supposing TETRAODON SPENGLERI to be a species with closed nostrils. The proper name for that group—(AROTHRON Müller: TETRAODON of several authors) seems to be OVOIDES Cuvier.

Cataphractus Klein, IV, 828, 1777; type COTTUS CATAPHRACTUS L. "CATAPHRACTUS ROSTRO RESIMO" Klein.

Not CATAPHRACTUS Gronow. Stands as AGONUS Lacepède.

Capriscus Klein, V, 427, 1777; type BALISTES CAPRISCUS Gmelin. "CAPRISCUS TRIBUS ACULEIS" Klein.

Synonym of BALISTES L.

Cestreus Klein, V, 460, 1777; type MUGIL CEPHALUS L. "CESTREUS DORSO REPANDO" Klein.

A synonym of MUGIL L.

XXIV. FORSTER, *Enchiridion*, 1778.

JOHN REINHOLD FORSTER.

Harpurus Forster, 84; type HARPURUS FASCIATUS FORSTER.

Equivalent to HEPATUS, TEUTHIS and ACANTHURUS.

XXV. KLEIN, *Gesellschaft Schauplatz*, vols. VI to X, 1778 to 1781.

JAKOB THEODOR KLEIN.

Solenostomus Klein, VI, 32, 1778; type FISTULARIA TABACCARIA L. "SOLENOSTOMUS CUTE GLABRA" Klein.

Synonym of FISTULARIA. If SOLENOSTOMUS is accepted, a new generic name is required for SOLENOSTSMUS Lacepède.

Sphyræna Klein, VI, 464, 1778; type ESOX SPHYRÆNA L.

Would replace SPHYRÆNA Röse, unless UMBLA Catesby is available.

Gobio Klein, VII, 178, 1779; type GOBIUS NIGER L. "GOBIO BRANCHIARUM OPERCULIS ET VENTRE FLAVICANTIBUS" Klein.

If allowed, GOBIO Klein becomes a synonym of GOBIUS L. and a new name would be required in place of GOBIO Cuvier.

Hippurus Klein, VII, 788, 1779; type CORYPHÆNA HIPPURUS L. "HIPPURUS PINNIS BRANCHIALIBUS" Klein.

Synonym of CORYPHÆNA L.

Blennus Klein, VIII, 589, 1779; type BLENNIUS OCELLARIS L. "BLENNUS PINNICEPS COLORIS" Klein.

Synonym of BLENNIUS L.

Psalisostomus Klein, X, 154, 1781; type ESOX OSSEUS L. "PSALISOSTOMUS OMNIUM MAXIMUS" Klein.

If allowed, replaces LEPISOSTEUS Lacepède.

XXVI. HERRMANN, *Schreiben ueber eine neues Americanisches Fischgeschlecht*, STERNOPTIX: Der Naturforscher, 2 Stück, vol. XVI, 1781.

JOHANN HERRMANN.

Sternoptix Herrmann, 8, 36; type STERNOPTIX DIAPHANA Herrmann.

Monotypic.

XXVII. HOUTTUYN, *Beskrivning van Eenige Japanske Visschen*: Actæ Harlemensis, XX, pt. 2, 1782.

MARTIN HOUTTUYN.

Centrogaster Houttuyn, 333; type CENTROGASTER FUSCESCENS Houttuyn.

A synonym of SIGANUS Forskål.

XXVIII. BLOCH, *Naturgeschichte der Ausländischen Fische*. Nine parts, 1785 to 1795. Part 2, 1786.

MARK ELIESER BLOCH.

Kurtus Bloch, II, 122, 1786; type KURTUS INDICUS Bloch.

Also written KYRTUS and CYRTUS. Monotypic.

Macrourus Bloch, II, 150, 1786; type CORYPHÆNA RUPESTRIS Fabricius, the "Ingmingoak" = MACROURUS BERGLAX Lacepède, which is not the same as CORYPHÆNOIDES RUPESTRIS Gunner.

XXIX. BLOCH, *Ueber Zwey Merkwürdige Fisch-Arten:* Abhandlungen Böhmischer Gesellschaft, I, 1787.

Notacanthus Bloch, 278; type NOTACANTHUS CHEMNITZI Bloch.

This name was changed by Bloch in 1797 to ACANTHONOTUS and the species to ACANTHONOTUS NASUS. Monotypic.

XXX. AHL, *De Muræna et Ophichtho,* 1787.

JONAS NICHOLAS AHL.

Ophichthus Ahl, 5; type MURÆNA OPHIS L., as restricted.
Unquestioned.

XXXI. ASCANIUS, *Beretning um Silde-Tusten*: Dansk. Selsk. 1788.

P. ASCANIUS

Regalecus Ascanius, III, 419; type OPHIDIUM GLESNE Ascanius.
Other dates have been quoted, for example "Icones," 1772, a series of plates of objects in nature. This may not be the oldest.

XXXII. BLOCH, *Charactere und Beschreibung des Geschlechts der Papageyfische,* CALLYODON: Abhandlungen Böhmischer Gesellschaft, IV, 1788.

MARK ELIESER BLOCH.

Callyodon Bloch, 242; type (presumably) SCARUS CROICENSIS Bloch.
Not seen by us.

XXXIII. BLOCH, *Naturgeschichte der Ausländischen Fische,* III, 1788.

Gymnetrus Bloch, III, 1; type GYMNETRUS HAWKENI Bloch.
A synonym of REGALECUS.

XXXIV. BROWNE, *Civil and Natural History of Jamaica,* Second Edition, 1789.

PATRICK BROWNE, M. D.

Originally published in 1756, reprinted in 1789, with a table showing the Linnæan equivalents of species named, and perhaps other revisions. No changes have been noted in the systematic part. In the original edition of 1756, as in later editions, the author refers to the works of Artedi and Gronow, with both of whom he was familiar. His recognition of genus as a technical term and not as a mere Latin noun is unmistakable. Browne adopts various genera of Artedi (later accepted by Linnæus), and to these he adds twelve new genera of his own. The species are

indicated by polynomial terms, to which are added the English vernacular names current in Jamaica.

The *History of Jamaica* is the ablest of all the works describing a local fish-fauna, prior to Linnæus, in quality comparable to the work of Osbeck, Hasselquist, and even of Forskål.

The revised republication of the work in 1789 may perhaps make the names of Browne eligible in nomenclature, if other authors rigidly correct as to generic names but polynomial as to species are to be considered. We have examined the original edition and the edition of 1789.

The names of Browne are perhaps not eligible as not binomial and as occurring in a slightly revised reprint of a pre-Linnæan work.

Following the precedent of Opinion 57, rejecting Hasselquist (*Iter Palestinum*), Browne's work would not be regarded as available.

Solenostomus Browne, 441; type "SOLENOSTOMUS CORPORE TERETE SUBROTUNDO etc., the Trumpeter" = FISTULARIA TABACCARIA L.

This name, if eligible, antedates SOLENOSTOMUS Klein and SOLENOSTOMUS Lacepède. Monotypic.

Menidia Browne, 441; type "MENIDIA CORPORE PELLUCIDO, LINEA LATERALI LATIORI ARGENTEA" = ATHERINA BROWNI Gmelin, 1789.

This name, if accepted, replaces ANCHOVIELLA Fowler, besides rendering MENIDIA Bonaparte ineligible. Monotypic.

Amia Browne, 442; type "AMIA SUBARGENTEA LABRIS ÆQUALIBUS OSSICULUS BRANCHIOSTEGUS VIGINTIDUOBUS, the Tarpon" = MEGALOPS ATLANTICUS Cuv. & Val.

This name is equivalent to TARPON Jordan & Evermann. It is however preoccupied by AMIA Gronow and by AMIA L. Browne refers also to AMIA, a second species, "the Ten-pounder," which is ELOPS SAURUS L., type of the genus ELOPS.

Mormyra Browne, 445; type "MORMYRA MAJOR CÆRULEA ET AUREO VARIA, the larger Painted Parrot-fish" = SCARUS VETULA Bloch & Schneider.

The name MORMYRA, too close to MORMYRUS L., is subsequent to CALLYODON of Gronow, and to SCARUS Forskål. Three other species of Parrot-fish are placed by Browne in MORMYRA. Synonym of CALLYODON.

Plagusia Browne, 445; type "PLAGUSIA SUBCINEREA CAUDA ATTENUATA, the little Brown Sole with a pointed tail" = PLEURONECTES PLAGUSIA Bloch & Schneider, 1801 = SYMPHURUS PLAGUSIA Jordan & Evermann.

The name PLAGUSIA was adopted for this genus by Cuvier in 1829. It had however been earlier (1806) used by Latreille for a genus of Crustaceans.

Browne's name PLAGUSIA, if available, has priority over SYMPHURUS Rafinesque, 1820, as well as over the numerous later names applied to this group, the best known of which are APHORISTIA Kaup and AMMOPLEUROPS Günther. As there is a still earlier species, PLAGUSIA PLAGIUSA L., in this genus, the present species may perhaps stand as PLAGUSIA ORNATA Lacepède, "PLAGIUSA" being only a variant spelling of the same word.

Helops Browne, 445; type "HELOPS NIGRESCENS VARIE NEBULATIM, the Hog-fish of Catesby" = LABRUS RUFUS L.

If HELOPS, with this type, is accepted, it will eliminate the much confused generic name BODIANUS Bloch, based on the same type (BODIANUS BODIANUS Bloch = LABRUS RUFUS L.). HARPE Lacepède and COSSYPHUS Cuvier are later names for the same genus. The first species indicated by Browne under HELOPS is LACHNOLAIMUS MAXIMUS (Walbaum), the "SUILLUS or Great Hog-fish" of Catesby. This is "HELOPS RUFESCENS IRIDE PARTIM RUBRA, PARTIM ALBIDA, MACULA NIGRA POST PINNIM DORSALEM, the Hog-fish" of Browne. In the interest of nomenclature, it would be better to suppress BODIANUS rather than LACHNOLAIMUS, if HELOPS is found eligible.

Cromis Browne, 449; type "CROMIS SUBARGENTEO OBLONGUS RADIIS ANTERIORIBUS DORSALIS ÆGRE PUNGENTIBUS, the Drummer" = LABRUS CROMIS L. = POGONIAS CHROMIS of authors.

Browne cites four species of his genus CROMIS, the "Silver Shad" (GERRES CINEREUS), the Red-mouth Grunt (HÆMULON PLUMIERI), the Stone Bass (DIAPTERUS BRASILIANUS), and the Drummer (POGONIAS CROMIS). As the last named became LABRUS CROMIS L., we may take it as the type of the genus CROMIS of Browne, if the latter is eligible. CROMIS would then, if accepted, replace POGONIAS Lacepède. CHROMIS Cuvier, 1815, a more correct spelling of the same word, would then give place to HELIASES Cuvier.

Macrocephalus Browne, 449; type "MACROCEPHALUS ARGENTEA MAJOR LINEA LATERALIS RECTA NIGRA, the Snook" = SCLÆNA UNDECIMALIS Bloch.

Monotypic. Equivalent to CENTROPOMUS Lacepède. Preoccupied by MACROCEPHALUS Swederus, 1787, a genus of Insects.

Pelmatia Browne, 449; type "PELMATIA MAJOR SQUAMIS VIX PERSPICUUS, the Mud-fish" = GOBIOMORUS DORMITOR Lacepède.

The name PELMATIA, if accepted, replaces GOBIOMORUS, which in turn has replaced the excellent name PHILYPNUS of Cuvier.

The first species named under PELMATIA by Browne is "PELMATIA MINOR SQUAMIS MAJUSCULUS, the Bullhead." This is DORMITATOR MACULATUS (Bloch). Browne gives a long and correct account of PELMATIA, and notes that his "second sort," the mud-fish, is "most esteemed and grows frequently to the length of 17 to 20 inches. It is the most delicate fish I have yet known, when in full perfection."

Thynnus Browne, 451; type "THYNNUS BONTII CORPORE CRASSIORI ET BREVIORE etc., The Boneeto" = SCOMBER PELAMYS L.

This use of the name THYNNUS is later than that of Fabricius, 1775, for a genus of Insects. It antedates THYNNUS of Cuvier and it is equivalent to THYNNUS of Lütken, a name later changed to EUTHYNNUS by its author. SCOMBER PELAMYS L., the Oceanic Bonito, is the Bonito of Cuba and Jamaica, where the Northern Bonito, SARDA SARDA, is unknown. Of the "Boneeto," Browne observes that it is "a dry coarse fish, not much esteemed, though a hearty wholesome food." Should stand as EUTHYNNUS Lütken. Monotypic.

Saurus Browne, 452; type "SAURUS ARGENTEUS CUTE LONGITUDINALIS etc., the Leather Coat" = SCOMBER SAURUS Bloch & Schneider = OLIGOPLITES SAURUS of authors.

Not SAURUS Cuv. & Val., which is SYNODUS Gronow. If Browne's names are accepted, SAURUS must replace OLIGOPLITES Gill, its type species standing as SAURUS SAURUS (Bloch & Schneider). Two other species of SAURUS are enumerated by Browne, the "Red-tailed Jack" and the "White-fish."

Teuthis Browne, 454; type "TEUTHIS FUSCA CÆRULEO NITENS, the Doctor (TURDUS RHOMBOIDES Catesby)" = CHÆTODON CÆRULEUS Bloch.

The first application of the name TEUTHIS (τεῦθις, a squid) to a fish is that of Browne in 1756. Linnæus in 1766 accepted Browne's name TEUTHIS, and substituted it for Gronow's name HEPATUS, 1763. The republication of TEUTHIS in 1789 would help to fix the generic name TEUTHIS with Browne's original species. HEPATUS Gronow was primarily based on a specimen of the West Indian species called CHÆTODON CHIRURGUS by Bloch, with which CHÆTODON CÆRULEUS Bloch, the type of TEUTHIS, is strictly congeneric. The other species concerned, TEUTHIS JAVUS L., wrongly referred by Gronow to HEPATUS, should stand as SIGANUS Forskål. Cuvier and Valenciennes, according to Günther, were in error in referring Gronow's specimen, the type of TEUTHIS HEPATUS L., to an East Indian species, since called COLOCOPUS LAMBDURUS Gill.

The four species entangled in the confusion superimposed upon Browne, should, as Gill has shown, stand as follows:

HEPATUS or TEUTHIS CÆRULEUS (Bloch & Schneider).
HEPATUS or TEUTHIS HEPATUS L.
COLOCOPUS LAMBDURUS Gill.
SIGANUS JAVUS (L.).

Rhomboida Browne, 455; type "RHOMBOIDA ALEPIDOTA ARGENTEA PINNIS OMNIS BREVIBUS, the Silver-fish" = VOMER BROWNI Cuv. & Val., 1833.

The generic name RHOMBOIDA antedates that of VOMER Cuvier, and, if accepted, the type species would stand as RHOMBOIDA BROWNI (Cuv. & Val.) = PLATYSOMUS SPIXI Swainson, a species distinct from the northern VOMER SETIPINNIS (Mitchill).

Under Rhomboida, Browne mentions also "RHOMBOIDA MAJOR ALEPIDOTA, the Larger Silver-fish, with long fins (ZEUS CAUDA BIFURCA Artedi)." This must be

SELENE VOMER L. A third species is "RHOMBOIDA SQUAMOSA EX ARGENTEA, the Portugise." This seems to be POMACANCHUS ARCUATUS L., the "Portugais" of the French Antillan fishermen.

XXXV. LINCK, *Magazin Neuestes aus der Physik und Naturgeschichte*, Gotha, 1790.

H. F. LINCK.

This work we have not seen; we quote from Gill.

Mustelus Linck, 31; type SQUALUS MUSTELUS L. = MUSTELUS LÆVIS of authors.

Equivalent to PLEURACROMYLON Gill, not quite the same as MUSTELUS Valmont.

Pristis Linck, 31; type SQUALUS PRISTIS L.

Unquestioned.

Rhinobatos Linck, 32; type not specified: RAJA RHINOBATOS L.

Equivalent to RHINOBATUS Klein.

Callichthys Linck, 32; type not specified: SILURUS CALLICHTHYS L.

Equivalent to CALLICHTHYS Gronow.

Alosa Linck, 35 (scarcely defined); type not specified: CLUPEA ALOSA L. = ALOSA Cuvier.

Thymallus Linck, 35; type not specified: SALMO THYMALLUS L. = THYMALLUS Cuvier.

Mola Linck, 37; type DIODON MOLA L.

Equivalent to MOLA Koelreuter and Cuvier.

Soarus Linck (misprint for SAURUS), 37; type not specified and unidentifiable.

Barbatula Linck, 38; type COBITIS BARBATULA L.

Replaces OREIAS Sauvage; ORTHRIAS Jordan & Fowler.

XXXVI. BLOCH, *Naturgeschichte der Ausländischen Fische*, IV, 1790.

MARK ELIESER BLOCH.

Bodianus Bloch, IV, 48; type BODIANUS BODIANUS Bloch, by tautonomy.

Replaces HARPE Lacepède. By first restriction, Cuvier and Gill, the type would be BODIANUS GUTTATUS Bloch, a species of ENNEACENTRUS Gill. Tautonomy has precedence in this case.

Lutianus Bloch, IV, 105; type LUTIANUS LUTIANUS Bloch.

Unquestioned. Also spelled LUTJANUS.

XXXVII. WHITE, *Journal of a Voyage to New South Wales*, 1790.

J. WHITE.

Enoplosus White, plate 39; type CHÆTODON ARMATUS White.

Lacepède quotes the name ENOPLOSUS from White. We have not seen this paper, and the name may have been first printed by Lacepède.

XXXVIII. VALMONT DE BOMARE, *Dictionnaire* etc., Edition IV, vol. VIII, 1791.

JEAN CHRISTOPHE VALMONT DE BOMARE.

Acus Valmont; type ACUS ARISTOTELIS Valmont = SYNGNATHUS ACUS L.

After Willughby. Same as SYNGNATHUS L.

XXXIX. SHAW, *Description of* STYLEPHORUS CHORDATUS, *a new fish*: Transactions of the Linnæan Society of London, I, 1791.

GEORGE SHAW.

Stylephorus Shaw, I, 90; type STYLEPHORUS CHORDATUS Shaw.

Monotypic.

XL. WALBAUM, *Artedi Piscium*, 1792.

JOHANN JULIUS WALBAUM.

Curimata Walbaum, 80; type SALMO MARCGRAVII Walbaum, based on "CHARAX MAXILLA SUPERIORE LONGIORE" Gronow, which is SALMO CYPRINOIDES L.

CURIMATA should replace CURIMATUS Cuvier for this genus.

XLI. BLOCH, *Naturgeschichte der Ansländischen Fische*, VI, VII, 1792, 1793.

MARK ELIESER BLOCH.

Anthias Bloch, VI, 97, 1792; type LABRUS ANTHIAS L. = ANTHIAS SACER Bloch.

Unquestioned. AYLOPON Rafinesque is a substitute name, ANTHIAS being said to be preoccupied. We do not find it so. ANTHIA, a genus of Beetles, dates from 1801.

Epinephelus Bloch, VII, 11, 1793; type EPINEPHELUS MARGINALIS Bloch = PERCA FASCIATA Forskål, by general consent.

The genus EPINEPHELUS was based on E. AFER, E. MARGINALIS, E. MERRA, and E. RUBER. MARGINALIS and MERRA are congeneric, and belong to the great group called EPINEPHELUS by Gill, Bleeker, and nearly all recent authors. Of these, MARGINALIS is typical. The species named first, AFER, has been on that account chosen as type by Fowler, 1907. This species was separated as the type of ALPHESTES by Bloch & Schneider, 1801. RUBER was named as type by Jordan & Gilbert, 1883. This species under another name (ACUTIROSTRIS Cuv. & Val.) became the type of PAREPINEPHELUS Bleeker, 1875. Justice and convenience are best served by retaining the name EPINEPHELUS for its chief components, as understood by nearly all authors. Otherwise the genus would stand as CERNA Bonaparte, 1837, unless, with Fowler, we recognize EPINEPHELUS GIGAS (PERCA GIGAS) L. as the type of SERRANUS Cuvier, 1817, a change we think unnecessary. If the subgenera of Forskål, with Arabic names, are recognized, EPINEPHELUS must give place to DABA.

Gymnocephalus Bloch, VII, 24, 1793; type PERCA SCHRÆTZER L., equivalent to CERNUA Schæfer, ACERINA Cuvier, and CERNUA Fleming.

Johnius Bloch, VII, 132, 1793; type JOHNIUS CARUTTA Bloch, as restricted by Gill.

Lonchiurus Bloch, VII, 143, 1793; type LONCHIURUS BARBATUS Bloch, 1793 = PERCA LANCEOLATA Bloch, 1788.

Monotypic. Corrected by later writers to LONCHURUS.

Cataphractus Bloch, VII, 80, 1793; type SILURUS CALLICHTHYS L. as here restricted.

A synonym of CALLICHTHYS.

XLII. RÖSE, *Petri Artedi Angermannia-Sueci Synonymia Nominum Piscium* etc. Greifswald. Edition II, 1793.

ANTON FERDINAND RÖSE.

This article, published as a supplement to Walbaum's *Artedi Piscium*, enumerates the generic names of Artedi and others, the species in their original polynomial form. In an Appendix are given a few new generic names, mostly taken from Aristotle. These genera are not described, nor are their species named, but the synonymy is fully given. Some of them had been already used by other authors. In our judgment, these names are eligible, and a few maintain priority of date.

Phycis Röse, 111; type φυκίς Aristotle, PHYCIS TINCA Bloch & Schneider. GADUS BLENNIOIDES Brünnich.

This is identical with PHYCIS Bloch & Schneider, 1801; the latter, but not the former, antedated by PHYCIS Fabricius, 1798, a genus of Insects. PHYCIS Röse replaces EMPHYCUS Jordan & Evermann, 1898.

Cicla Röse, 112; type "CICLA VIX PALMARIS" Röse, κίχλη Aristotle, a species of LABRUS, perhaps L. VIRIDIS L.

CICLA Klein is identical with that of Röse. Schneider, more correctly, wrote the word CICHLA, but applied it to a different group.

Sphyræna Röse, 112; type σφύραινα Aristotle = ESOX SPHYRÆNA L.

This antedates SPHYRÆNA Bloch & Schneider, 1801, for the same genus.

Hepatus Röse, 113; type ἥπατος Aristotle, which is probably LABRUS HEPATUS L., the type of the genus PARACENTROPRISTIS Bleeker.

HEPATUS Gronow is wholly different.

Capriscus Röse, 114; type καπρίσκος Diphili, κάπρος Aristotle, which is probably BALISTES CAPRISCUS L.

A synonym of BALISTES L.

Tænia Röse, 114; type ταινία Aristotle = CEPOLA TÆNIA L.

The genus is equivalent to CEPOLA L., and is preoccupied in Worms by TÆNIA L.

Pholis Röse, 116; type φολὶς Aristotle = BLENNIUS PHOLIS L.

Equivalent to PHOLIS Cuv. & Val., not of Scopoli, 1777.

Citharus Röse, 116; type κιθάρος Aristotle = PLEURONECTUS LINGUATULA L.

Equivalent to CITHARUS Bleeker, 1862, and EUCITHARUS Gill, 1888; not CITHARUS Reinhardt, 1838, which is HIPPOGLOSSOIDES.

Liparis Röse, 117; type "LIPARIS NOSTRAS Johnson" = CYCLOPTERUS LIPARIS L.

Equivalent to CYCLOGASTER Gronow and LIPARIS Scopoli.

Chelon Röse, 118; type χάλλων or χέλων Aristotle, CHELON of Gesner, which is probably MUGIL CHELO Cuv. & Val.

Probably equivalent to CHÆNOMUGIL Gill, but the European and American types need further comparison.

XLIII. LATHAM, *Essay on the various species of Saw-Fish:* Transactions of the Linnæan Society of London, 1794.

JOHN F. LATHAM.

Pristis Latham, II, 276; type SQUALUS PRISTIS L.

Same as PRISTIS Linck.

XLIV. VAHL, *Beskrivelse af en nye Fiskeslaegt:* Shrivt. Naturh. Selsk., Kjöbenhavn, III, 1794.

M. VAHL.

Cæcula Vahl, III, 2, 149; type CÆCULA PTERYGERA Vahl.

Monotypic.

XLV. BLOCH, *Naturgeschichte der Ausländischen Fische*, VIII, 1794; IX, 1795.

MARK ELIESER BLOCH.

Platystacus Bloch, VIII, 52, 1794; type PLATYSTACUS COTYLEPHORUS Bloch, as usually restricted.

Ophicephalus Bloch, VIII, 137, 1794; type OPHICEPHALUS PUNCTATUS Bloch.

Unquestioned. Corrected by later writers to OPHIOCEPHALUS.

Sphagebranchus Bloch, IX, 88, 1795; type SPHAGEBRANCHUS ROSTRATUS Bloch.

Monotypic.

Gymnothorax Bloch, IX, 83, 1795; type GYMNOTHORAX MURÆNA Bloch = MURÆNA HELENA L.

A synonym of MURÆNA L. Günther, *Cat. Fish*, VIII, p. 100, 1870, restricts the names to allies of MURÆNA AFRA = LYCODONTIS McClelland, an arrangement apparently not defensible, as GYMNOTHORAX was plainly a substitute name for MURÆNA, and must retain the same type, MURÆNA HELENA L.

Synbranchus Bloch, IX, 86, 1795; type SYMBRANCHUS MARMORATUS Bloch.

Name corrected by later writers to SYMBRANCHUS.

Platycephalus Bloch, IX, 96, 1795; type PLATYCEPHALUS SPATHULA Bloch = COTTUS INSIDIATOR Forskål = CALLIONYMUS INDICUS L.

Unquestioned.

Gastrobranchus Bloch, XII, 51, 1797; type GASTROBRANCHUS CÆCUS Bloch = MYXINE GLUTINOSA L.

A synonym of MYXINE L.

Acanthonotus Bloch, XII, 113, 1797; type ACANTHONOTUS NASUS Bloch, 1797 = NOTACANTHUS CHEMNITZI Bloch, 1787.

A needless substitute name for NOTACANTHUS.

XLVI. FABRICIUS, *Beskrivelse over to sieldne Grönländske Fiske*: Skrivt. Naturhist. Selskab. Kjöbenhavn, 1793, II.

OTTO FABRICIUS.

Campylodon Fabricius, 12; type CAMPYLODON (FABRICII Reinhardt), 1838.

A synonym of NOTACANTHUS Bloch. Mononomial and monotypic.

XLVII. VOLTA, *Ichthyolithologia Veronensis,* 1796.

SERAFINO VOLTA.

Blochius Volta, 53; type BLOCHIUS LONGIROSTRIS Volta (Family BLOCHIIDÆ, fossil).

XLVIII. LACEPÈDE, *sur le Polyodon feuille:* Bull. Sci. Soc. Philom., 1797.

BERNARD GERMAIN ÉTIENNE DE LA VILLE-SUR-ILLON COMTE DE LACEPÈDE.

The name of this author should be written Lacepède. Sherborne, *Index Animalium,* says: "A letter dated 1831 is signed 'b. g. é cte. de Lacepède.' This spelling and accentuation should be adhered to."

Polyodon Lacepède, 49; type POLYODON FOLIUM Lacepède.
Monotypic.

XLIX. CUVIER, *Tableau Élémentaire,* 1798.

GEORGES JEAN LEOPOLD NICOLAS FRÉDÉRIC CUVIER.

Mola Cuvier, 323; type DIODON MOLA L.
Equivalent to MOLA Kœlreuter. Prior to ORTHAGORISCUS Bloch & Schneider, 1801. Monotypic.

Muraenophis Cuvier, 329; type MURÆNA HELENA L.
A synonym of MURÆNA L.

L. GEOFFROY SAINT HILAIRE, *Description d'un nouveau Genre de Poisson:* Bull. Soc. Sci. Philom., III, "An X de la République," 1798.

ÉTIENNE GEOFFROY SAINT HILAIRE.

Polypterus St. Hilaire, 97; type POLYPTERUS BICHIR St. Hilaire.
Monotypic.

LI. RETZIUS, *Lampris, En ny Fiskslagt Beskriven:* Vet. Acad. Nya Handl., Stockholm, XX, 1799.

A. J. RETZIUS.

Lampris Retzius, 91; type ZEUS GUTTATUS Brünnich = ZEUS REGIUS Bonnaterre.

LII. SHAW, *Naturalist's Miscellany*, 1799.

GEORGE SHAW.

Trachichthys Shaw, 378; type TRACHICHTHYS AUSTRALIS Shaw.
Monotypic.

LIII. CUVIER, *Leçons d'Anatomie Comparée*, 1800.

GEORGES CUVIER.

Ovoides Cuvier, 1, tab. 1; type OVOIDES FASCIATUS Lacepède = TETRODON STELLATUS.
After "LES OVOIDES Lacepède," 1798. Replaces AROTHRON Müller.

LIV. LACEPÈDE, *Histoire Naturelle des Poissons*, *vol. I, 1798; II, 1800.

BERNARD GERMAIN ÉTIENNE DE LA VILLE-SUR-ILLON, COMTE DE LACEPÈDE (here called "CITOYEN LA CEPÈDE").

The generic names in Volume I, 1798, and Volume II, 1800, to page 160, are nearly all given in French vernacular and are therefore ineligible. Scientific forms for most of these were supplied by Duméril, *Zoologie Analytique*, 1806, from which work the generic names in question must be dated.

Aodon Lacepède, I, 297, 1798; type SQUALUS MASSASA Forskål, as restricted by Jordan & Evermann.

A shark, perhaps imaginary, with no teeth and with long pectorals. The Latin name AODON is used, as well as the French "LES AODONS."

Ovoides (Lacepède), 521, "LES OVOIDES"; type "L'OVOIDE FASCÉ."

A front view of TETRAODON STELLATUS L. Equivalent to OVOIDES Cuvier.

Spheroides (Lacepède) Duméril (LES SPHÉROIDES), II, 22, 1800; type LE SPHÉROIDE TUBERCULÉ Lacepède.

A front view of TETRAODON SPENGLERI Bloch. A synonym of TETRAODON as here understood.

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* Of this work we have before us two reprints, neither with the original pagination. This, however, we are able to give, through the kindness of Mr. Henry W. Fowler of the Academy of Natural Sciences of Philadelphia, who has supplied us with a complete list of the genera and the pages on which they occur.

In the original edition the author styles himself "Citoyen La Cepède."

Macrorhynchus (Lacepède) Duméril (LES MACRORHYNQUES); type LE MACRORHINQUE ARGENTÉ Lacepède, SYNGNATHUS ARGENTEUS Osbeck.

Probably replaces DICROTUS Günther.

Cæcilia Lacepède), II, 134, 1800 (LES CÆCILIES); type CÆCILIA BRANDERIANA Lacepède = MURÆNA CÆCA L.

Not CÆCILIA L., a genus of Amphibians. A synonym of SPHAGEBRANCHUS Bloch.

Monopterus (Lacepède), Duméril, II, 138, 1800 (LES MONOPTÈRES); type MONOPTERUS JAVANENSIS Lacepède.

Notopterus Lacepède, II, 189, 1800; type GYMNOTUS KAPERAT Bonnaterre (GYMNOTUS NOTOPTERUS Pallas).

Ophisurus Lacepède, II, 195, 1800; type MURÆNA SERPENS L. as restricted by Risso, 1826.

Triurus Lacepède, II, 200, 1800; type TRIURUS BOUGAINVILLEI Lacepède, later called POMATIAS by Bloch & Schneider.

Unidentified. A deep-sea fish, apparently allied to AULOSTOMATOMORPHA Alcock, but without ventral fins.

Apteronotus Lacepède, II, 208, 1800; type APTERONOTUS PASSAN Lacepède = GYMNOTUS ALBIFRONS L.

Must replace STERNARCHUS Bloch & Schneider.

Odontognathus Lacepède, 220, 1800; type ODONTOGNATHUS MURICATUS Lacepède.

Macrognathus Lacepède, II, 283, 1800; type OPHIDIUM ACULEATUM L.

Replaces RHYNCHOBDELLA Bloch & Schneider, with the same type. The name MACROGNATHUS was used by Gronow in 1754 (but not in 1763) to designate the group called BELONE Cuvier.

Comephorus Lacepède, II, 312, 1800; type CALLIONYMUS BAIKALENSIS Bonnaterre.

Monotypic.

Rhombus Lacepède, II, 312, 1800; type STROMATEUS ALEPIDOTUS L.

Preoccupied, replaced by PEPRILUS Cuvier.

Muraenoides Lacepède, II, 324, 1800; type BLENNIUS MURÆNOIDES Sujef (BLENNIUS GUNNELLUS L.).

Equivalent to PHOLIS Scopoli, 1777.

Calliomorus Lacepède, II, 343, 1800; type CALLIONYMUS INDICUS L.

Synonym of PLATYCEPHALUS Bloch.

Batrachoides Lacepède, II, 351, 1800; type BATRACHOIDES TAU Lacepède.

Not GADUS TAU L.

Because the body is said to be covered with scales, "molles, petites, minces, rondes, brunes, bordees de blanc et arrosées par une mucosité três abondantes," we cannot identify this genus with the naked GADUS TAU L., which is identical with the type of OPSANUS Rafinesque.

Oligopodus Lacepède, II, 511, 1800; type CORYPHÆNA VELIFERA Pallas.

Equivalent to PTERACLIS Gronow.

Hiatula Lacepède, II, 522, 1800; type HIATULA GARDENIANA Lacepède = LABRUS ONITIS L. = LABRUS HIATULA L.

Not HIATULA Modeer, 1793, a genus of Mollusks. Gives way to TAUTOGA Cuvier.

Tænioides Lacepède, II, 532, 1800; type TÆNIOIDES HERMANNIANUS Lacepède.

Gobioides Lacepède, II, 576, 1800; type GOBIUS BROUSSONETI Lacepède, as restricted by Jordan & Evermann, 1898.

Gobiomorus Lacepède, II, 583, 1800; type GOBIOMORUS DORMITOR Lacepède, as restricted by Jordan.

Replaces PHILYPNUS Bloch & Schneider, 1801.

Gobiomoroides Lacepède, II, 592, 1800; type GOBIOMOROIDES PISON Lacepède = GOBIUS PISONIS L., a species of ELEOTRIS Gronow.

Monotypic.

Gobiesox Lacepède, II, 595, 1800; type GOBIESOX CEPHALUS Lacepède.

Monotypic.

LV. BLOCH & SCHNEIDER, *Systema Ichthyologia*, 1801.

MARK ELIESER BLOCH.
Edited and extended by JOHANN GOTTLOB SCHNEIDER.

Batrachus Bloch & Schneider, 42; type BATRACHUS SURINAMENSIS Schneider, as restricted by Jordan & Evermann.

The name has been usually applied to the congeners of GADUS TAU L., not of Bloch, the group called OPSANUS by Rafinesque. But no ally of the scaleless GADUS TAU is placed in BATRACHOIDES by Lacepède or in BATRACHUS by Schneider, only scaly species being known to either.

Enchelyopus Bloch & Schneider, 50; type, as first restricted, GADUS CIMBRIUS L. (RHINONEMUS CIMBRIUS Gill).

Not ENCHELYOPUS of Gronow, which is ZOARCES Cuvier, nor of Klein, which is TRICHIURUS.

Phycis Bloch & Schneider, 56; type BLENNIUS PHYCIS L. (PHYCIS TINCA Bloch & Schneider).

Equivalent to PHYCIS Röse, 1793; not PHYCIS Fabricius, 1798, a genus of Butterflies.

Periophthalmus Bloch & Schneider, 63; type PERIOPHTHALMUS PAPILIO Bloch & Schneider.

Eleotris Bloch & Schneider, 65; type ELEOTRIS Gronow (GOBIUS PISONIS Gmelin).

The name is borrowed from Gronow, whose ELEOTRIS is the ELEOTRIS of Cuvier and subsequent authors. But ELEOTRIS PISONIS is indicated by Schneider as "a species of doubtful relations, perhaps a PERIOPHTHALMUS." We let the current arrangement stand, though on shaky foundation, unless the names of Gronow are finally accepted. The genus ELEOTRIS of Bloch & Schneider represents an utter confusion of species, many of them not gobies at all.

Brama Bloch & Schneider, 98; type SPARUS RAJI Bloch.

Not BRAMA Klein, which is ABRAMIS Cuvier.

Monocentris Bloch & Schneider, 100; type GASTEROSTEUS JAPONICUS Houttuyn.

Monotypic.

Sphyræna Bloch & Schneider, 109; type ESOX SPHYRÆNA L.

Equivalent to UMBLA Catesby. Subsequent to SPHYRÆNA Röse.

Trichogaster Bloch & Schneider, 164; type TRICHOGASTER FASCIATUS Bloch & Schneider.

Centronotus Bloch & Schneider, 165; type CENTRONOTUS FASCIATUS Schneider.

A synonym of PHOLIS Scopoli.

Percis Bloch & Schneider, 179; type PERCIS MACULATA Schneider.

Not PERCIS Klein nor of Scopoli. Replaced by PARAPERCIS Bleeker. Monotypic.

Trichonotus Bloch & Schneider, 179; type TRICHONOTUS SETIGER Bloch & Schneider.

Monotypic.

Monoceros Bloch & Schneider, 180; type MONOCEROS BIACULEATUS Bloch & Schneider (CHÆTODON UNICORNIS Forskål).

Name preoccupied in Mollusks. Equivalent to NASO Lacepède.

Grammistes Bloch & Schneider, 182; type PERCA SEXLINEATA Thunberg.

A jumble of striped fishes, restricted by Cuvier to the GRAMMISTES of Seba, G. SEXLINEATUS.

Synanceja Bloch & Schneider, 194; type SCORPÆNA HORRIDA L.

By common consent. Commonly written SYNANCEIA.

Amphiprion Bloch & Schneider, 200; type LUTJANUS EPHIPPIUM Bloch.

Amphacanthus Bloch & Schneider, 206; type CHÆTODON GUTTATUS Bloch.

Equivalent to TEUTHIS L. as restricted = SIGANUS Forskål.

Alphestes Bloch & Schneider, 236; type ALPHESTES AFER Bloch & Schneider.

Cephalopholis Bloch & Schneider, 311; type CEPHALOPHOLIS ARGUS Bloch & Schneider.

Monotypic. Replaces ENNEACENTRUS Gill.

Calliodon Bloch & Schneider, 312; type CALLIODON LINEATUS Bloch & Schneider (SCARUS CROICENSIS Bloch).

Equivalent to CALLYODON Gronow.

Cichla Bloch & Schneider, 336; type CICHLA OCELLARIS Bloch & Schneider as restricted by Heckel, 1840.

Name to be changed if CICLA Klein is eligible.

Rhina Bloch & Schneider, 353; type RHINA ANCYLOSTOMUS Bloch & Schneider.

Not of Klein; equivalent to RHAMPHOBATIS Gill.

Rhinobatus Bloch & Schneider, 353; type RAJA RHINOBATUS Forskål.

Equivalent to RHINOBATOS Linck.

Anableps Bloch & Schneider, 389; type ANABLEPS TETROPHTHALMUS Bloch & Schneider (COBITIS ANABLEPS L.).

Equivalent to ANABLEPS Gronow and of Scopoli.

Synodus Bloch & Schneider, 396; type ESOX SYNODUS L.

Replaces SAURUS Cuvier.

Chauliodus Bloch & Schneider, 430; type CHAULIODUS SLOANI Schneider.

Albula Bloch & Schneider, 433; type ALBULA CONORHYNCHUS Schneider (ESOX VULPES L.). ALBULA Gronow.

Not ALBULA Osbeck. To stand as BUTYRINUS Lacepède, if Osbeck's names are accepted.

Pœcilia Bloch & Schneider, 453; type PŒCILIA VIVIPARA Bloch & Schneider.

By common consent.

Polyodon (Lacepède) Bloch & Schneider, 457; type "LE POLYDON FEUILLE" Lacepède, 1798 = SQUALUS SPATHULA Walbaum.

Rhynchobdella Bloch & Schneider, 479; type RHYNCHOBDELLA ORIENTALIS Bloch & Schneider = OPHIDIUM ACULEATUM Bloch.

As restricted by Cuvier. A synonym of MACROGNATHUS Lacepède, 1800.

Sternarchus Bloch & Schneider, 497; type GYMNOTUS ALBIFRONS L.

A synonym of APTERONOTUS Lacepède, 1800.

Orthagoriscus Bloch & Schneider, (misprinted ORTHRAGORISCUS), 510; type DIODON MOLA (Bloch).

Equivalent to MOLA Kœlreuter.

Bogmarus Bloch & Schneider, 518; type BOGMARUS ISLANDICUS Bloch & Schneider (GYMNOGASTER ARCTICUS Brünnich).

A synonym of TRACHIPTERUS Gouan. Monotypic.

Gymnonotus Bloch & Schneider, 521; type GYMNOTUS CARAPO L. (corrected spelling for GYMNOTUS).

Ovum Bloch & Schneider, 530; type OVUM COMMERSONI Bloch & Schneider = "L'OVOIDE FASCÉ, Lacepède, 1798.

Monotypic. Equivalent to OVOIDES Cuvier. OVUM Martin, 1764, is recorded by Sherborne as a "vernacular name only."

Typhlobranchus Bloch & Schneider, 537; type TYPHLOBRANCHUS SPURIUS Bloch & Schneider.

Monotypic, not identified. A river eel of Tropical America, without gill-openings. Doubtless a synonym of SYMBRANCHUS.

Gnathobolus Bloch & Schneider, 556; type ODONTOGNATHUS MUCRONATUS Lacepède.

Equivalent to ODONTOGNATHUS.

Pomatias Bloch & Schneider, 559; type TRIURUS BOUGAINVILLEI Lacepède.

Equivalent to TRIURUS.

Fluta Bloch & Schneider, 565; type MONOPTERUS JAVANENSIS Lacepède.

Equivalent to MONOPTERUS. Like the two preceding, a needless substitute name.

LVI. LACEPÈDE, *Histoire Naturelle des Poissons*, vol. III, 1802; IV and V, 1803.

BERNARD GERMAIN LACEPÈDE.

Scomberoides Lacepède, III, 50, 1802; type SCOMBEROIDES COMMERSONIANUS Lacepède (SCOMBER LYSAN Forskål).

Caranx Lacepède, III, 57, 1802; type SCOMBER CARANGUS Bloch = CARANX HIPPOS L., as restricted by Bleeker, the first reviser.

The generic name CARANX was taken by Lacepède from the manuscripts of Commerson, who first applied the name to SCOMBER SPECIOSUS Forskål. In revising the genus, Bleeker referred SPECIOSUS to a new genus, GNATHANODON. This view Dr. Gill accepted at first, but later selected SPECIOSUS as the type of CARANX, leaving some older name as TRICROPTERUS Rafinesque or CARANGUS Griffith for the bulk of the species of this extensive group. Later, by the process of elimination, CARANX RUBER was selected by Jordan as type of CARANX. On the whole it seems

most just, as it is certainly most convenient, to recognize the right of Bleeker as "first reviser." CARANX CARANGUS is congeneric with C. RUBER.

Trachinotus Lacepède, III, 78, 1802; type SCOMBER FALCATUS Forskål.

Caranxomorus Lacepède, III, 82, 1802; type SCOMBER PELAGICUS L.

Synonym of CORYPHÆNA L.

Cæsio Lacepède, III, 85, 1802; type CÆSIO CÆRULEOAUREUS Lacepède.

Cæsiomorus Lacepède, III, 92, 1802; type CÆSIOMORUS BAILLONI Lacepède.

Genus probably valid; equivalent to GLAUCUS Klein.

Coris Lacepède, III, 96, 1802; type CORIS AYGULA Lacepède.

Gomphosus Lacepède, III, 100, 1802; type GOMPHOSUS CÆRULEUS Lacepède.

Naso Lacepède, III, 105, 1802; type CHÆTODON FRONTICORNIS L.

Adopted from Commerson ms. Commerson writes NASEUS, but the form NASO occurs first. Identical with MONOCEROS Bloch & Schneider, the latter preoccupied.

Kyphosus Lacepède, III, 114, 1802; type KYPHOSUS BIGIBBUS Lacepède.

Osphronemus Lacepède, III, 116, 1802; type OSPHRONEMUS GOURAMY Lacepède.

Written OSPHROMENUS by Günther.

Trichopodus Lacepède, III, 125, 1802; type TRICHOPODUS MENTUM Lacepède (OSPHRONEMUS GOURAMY Lacepède).

Monodactylus Lacepède, III, 131, 1802; type MONODACTYLUS FALCIFORMIS Lacepède.

Called PSETTUS by Commerson in ms. as quoted by Lacepède. Monotypic.

Plectorhinchus Lacepède, III, 134, 1802; type PLECTORHINCHUS CHÆTODONOIDES Lacepède.

Monotypic. Replaces DIAGRAMMA Cuvier.

Pogonias Lacepède, III, 137; type POGONIAS FASCIATUS Lacepède = LABRUS CROMIS Lacepède.

Bostrychus Lacepède, III, 144, 1802; type BOSTRYCHUS SINENSIS Lacepède.

Not BOSTRICHUS Geoffroy 1762, a genus of Insects. Replaced by BOSTRICHTHYS Duméril, 1806, by PSILUS Fischer, 1813, and by ICTIOPOGON Rafinesque, 1815.

Bostrychoides Lacepède, III, 144, 1802; type BOSTRYCHOIDES OCULATUS Lacepède.

Monotypic.

Hemipteronotus Lacepède, III, 214, 1802; type HEMIPTERONOTUS QUINQUEMACULATUS Lacepède (CORYPHÆNA PENTADACTYLA Gmelin).

Coryphænoides Lacepède, III, 219, 1802; type CORYPHÆNOIDES HOUTTUYNI Lacepède (CORYPHÆNA JAPONICA Houttuyn).

Not CORYPHÆNOIDES Gunner. Replaced by BRANCHIOSTEGUS Rafinesque, 1815, which is earlier than LATILUS Cuvier & Val., 1830.

Aspidophorus Lacepède, III, 221, 1802; type ASPIDOPHORUS ARMATUS Lacepède (COTTUS CATAPHRACTUS Lacepède).

Equivalent to AGONUS Bloch & Schneider.

Aspidophoroides Lacepède, III, 227, 1802; type ASPIDOPHOROIDES TRANQUEBAR Lacepède (AGONUS MONOPTERYGIUS Bloch & Schneider).

Scomberomorus Lacepède, III, 292, 1802; type SCOMBEROMORUS PLUMIERI Lacepède (SCOMBER REGALIS Bloch).

Centropodus Lacepède, III, 303, 1802; type SCOMBER RHOMBEUS Forskål.

A synonym of MONODACTYLUS Lacepède.

Centronotus Lacepède, III, 309, 1802; type CENTRONOTUS CONDUCTOR Lacepède (GASTEROSTEUS DUCTOR Lacepède).

Not CENTRONOTUS Bloch & Schneider, 1801 (PHOLIS Scopoli). Replaced by NAUCRATES Rafinesque.

Lepisacanthus Lacepède, III, 320, 1802; type LEPISACANTHUS JAPONICUS Lacepède (GASTEROSTEUS JAPONICUS L.).

Equivalent to MONOCENTRIS Bloch & Schneider, 1801. Monotypic.

Cephalacanthus Lacepède, III, 323, 1802; type GASTEROSTEUS SPINARELLA L.

The young of some species of DACTYLOPTERUS. Monotypic.

Dactylopterus Lacepède, III, 325, 1802; type DACTYLOPTERUS PIRAPEDA Lacepède (TRIGLA VOLITANS L.).

Equivalent to CEPHALACANTHUS Lacepède.

Prionotus Lacepède, III, 336, 1802; type PRIONOTUS EVOLANS Lacepède.

Monotypic.

Peristedion Lacepède, III, 368, 1802; type PERISTEDION MALARMAT Lacepède (TRIGLA CATAPHRACTA L.).

Monotypic.

Istiophorus Lacepède, III, 374, 1802; type SCOMBER GLADIUS Broussonet.

Monotypic. Spelled HISTIOPHORUS by Cuvier.

Apogon Lacepède, III, 411, 1802; type APOGON RUBER Lacepède (MULLUS IMBERBIS L.).

Monotypic. Equivalent to AMIA Gronow.

Macropodus Lacepède, III, 416, 1802; type MACROPODUS VIRIDIAURATUS Lacepède.

Monotypic.

Cheilinus Lacepède, III, 529, 1802; type CHEILINUS TRILOBATUS Lacepède.

Monotypic.

Cheilodipterus Lacepède, III, 539, 1802; type CHEILODIPTERUS LINEATUS Lacepède = CHEILODIPTERUS OCTOVITTATUS Cuv. & Val., as restricted by Cuv. & Val.

Hologymnosus Lacepède, III, 556, 1802; type HOLOGYMNOSUS FASCIATUS Lacepède (CORIS ANNULATUS Lacepède, 1802).

Equivalent to CORIS.

Ostorhinchus Lacepède, IV, 23, 1803; type OSTORHINCHUS FLEURIEU Lacepède.

Monotypic; subgenus of APOGON.

Dipterodon Lacepède, IV, 165, 1803; type DIPTERODON HEXACANTHUS Lacepède.

A species of APOGON, as restricted by Jordan & Evermann, *Fishes North Mid. Amer.*, 1106. Not DIPTERODON Cuvier.

Centropomus Lacepède, IV, 248, 1803; type SCIÆNA UNDECIMALIS Bloch, by common consent, as restricted by Cuvier.

Originally a peculiarly confused jumble of species.

Tænianotus Lacepède, IV, 303, 1803; type TÆNIONOTUS TRIACANTHUS Lacepède, restricted by Cuv. & Val., *Hist. Poiss.*, IV, 371.

Micropterus Lacepède, IV, 324, 1803; type MICROPTERUS DOLOMIEU Lacepède.

Monotypic.

Harpe Lacepède, IV, 426, 1803; type HARPE CÆRULEOAUREUS Lacepède (LABRUS RUFUS L.).

A synonym of BODIANUS Bloch and of HELOPS Browne.

Pimelepterus Lacepède, IV, 429, 1803; type PIMELEPTERUS BOSCI Lacepède.

Monotypic. A synonym of KYPHOSUS Lacepède.

Cheilio Lacepède, IV, 432, 1803; type CHEILIO AURATUS Lacepède (LABRUS INERMIS Forskål).

Pomatomus Lacepède, IV, 435, 1803; type POMATOMUS SKIB Lacepède (PERCA SALTATRIX L.).

Monotypic. The name afterwards improperly transferred by Cuvier to a genus of APOGONIDÆ, EPIGONUS Rafinesque.

Leiostomus Lacepède, IV, 438, 1803; type LEIOSTOMUS XANTHURUS Lacepède.

Monotypic.

Centrolophus Lacepède, IV, 441; type PERCA NIGRA L.

Leiognathus Lacepède, IV, 448; type LEIOGNATHUS ARGENTEUS Lacepède (SCOMBER EDENTULUS Bloch).

Monotypic. Prior to EQUULA Cuvier.

Acanthinion Lacepède, IV, 499, 1803; type CHÆTODON RHOMBOIDES L.

Equivalent to TRACHINOTUS.

Chætodipterus Lacepède, IV, 503; type CHÆTODIPTERUS PLUMIERI Lacepède (ZEUS FABER Gmelin).

Monotypic.

Pomacentrus Lacepède, IV, 505, 1803; type CHÆTODON PAVO Bloch.

By general consent.

Pomadasys Lacepède, IV, 515, 1803; type SCIÆNA ARGENTEA Forskål.

Monotypic. Prior to PRISTIPOMA Cuvier.

Pomacanthus Lacepède, IV, 517, 1803; type CHÆTODON ARCUATUS L., as restricted by Cuvier.

Holacanthus Lacepède, IV, 525, 1803; type CHÆTODON TRICOLOR L., as restricted by Cuvier.

Enoplosus (White) Lacepède, IV, 540, 1803; type CHÆTODON ARMATUS White.

Monotypic.

Glyphisodon Lacepède, IV, 542, 1803; type GLYPHISODON MOUCHARRA Lacepède (CHÆTODON SAXATILIS L.).

Equivalent to ABUDEFDUF Forskål. Usually written GLYPHIDODON.

Aspisurus Lacepède, IV, 556, 1803; type CHÆTODON SOHAR Forskål.

Monotypic. Equivalent to ACANTHURUS Forskål, TEUTHIS L.

Acanthopodus Lacepède, IV, 558, 1803; type ACANTHOPODUS ARGENTEUS Lacepède (MONODACTYLUS FALCIFORMIS Lacepède).

A synonym of MONODACTYLUS.

Selene Lacepède, IV, 560, 1803; type SELENE ARGENTEA Lacepède (ZEUS VOMER Cuvier).

Argyreiosus Lacepède, IV, 566, 1803; type ZEUS VOMER L.

Monotypic. A synonym of SELENE.

Gallus Lacepède, IV, 583, 1803; type GALLUS VIRESCENS Lacepède (ZEUS GALLUS L.).

Monotypic. Not GALLUS L., a genus of hens. Replaced by ALECTIS Rafinesque and GALLICHTHYS Cuvier.

Chrysotosus Lacepède, IV, 586, 1803; type ZEUS LUNA Gmelin.
A synonym of LAMPRIS. Monotypic.

Capros Lacepède, IV, 590, 1803; type ZEUS APER L.
Monotypic.

Achirus Lacepède, IV, 658, 1803; type PLEURONECTES ACHIRUS L.
As fixed by Jordan & Gilbert, 1883. ACHIRUS FASCIATUS Lacepède was wrongly supposed to be identical with PLEURONECTES ACHIRUS L.

Makaira Lacepède, IV, 688, 1803; type MAKAIRA NIGRICANS Lacepède.
Monotypic. A synonym of ISTIOPHORUS.

Cirrhitus Lacepède, V, 2, 1803; type CIRRHITUS MACULATUS Lacepède.
Monotypic. Written CIRRHITES by Cuvier.

Cheilodactylus Lacepède, V, 5, 1803; type CHEILODACTYLUS FASCIATUS Lacepède.
Monotypic.

Misgurnus Lacepède, V, 16, 1803; type COBITIS FOSSILIS L.
Monotypic.

Fundulus Lacepède, V, 37, 1803; type FUNDULUS MUDFISH Lacepède (COBITIS HETEROCLITA Gmelin).

Colubrina Lacepède, V, 40, 1803; type COLUBRINA CHINENSIS Lacepède.
An unidentified Chinese painting, probably fictitious.

Butyrinus Lacepède, V, 45, 1803; type BUTYRINUS BANANA Lacepède (ESOX VULPES L.).
Equivalent to ALBULA of Gronow and of Schneider, not ALBULA Osbeck. Should apparently replace ALBULA Gronow.

Tripteronotus Lacepède, V, 47, 1803; type TRIPTERONOTUS HAUTIN Lacepède (SALMO LAVARETUS L.).
Mutilated example. Equivalent to COREGONUS L.

Ompok Lacepède, V, 49, 1803; type OMPOK SILUROIDES Lacepède.
Replaces CALLICHROUS Hamilton.

Macropteronotus Lacepède, V, 84, 1803; type MACROPTERONOTUS CHARMUTH Lacepède (SILURUS ANGUILLARIS L.).
Identical with CLARIAS Gronow.

Malapterurus Lacepède, V, 90, 1803; type SILURUS ELECTRICUS L.
Monotypic. A synonym of TORPEDO Forskål.

Pimelodus Lacepède, V, 93, 1803; type PIMELODUS MACULATUS Lacepède.
As restricted by Cuvier, Gill and authors.

Doras Lacepède, V, 116, 1803; type SILURUS CARINATUS L.

Pogonathus Lacepède, V, 120, 1803; type POGONATHUS COURBINA Lacepède.
Identical with POGONIAS Lacepède, 1802.

Plotosus Lacepède, V, 129, 1803; type PLATYSTACUS ANGUILLARIS Bloch (SILURUS ANGUILLARIS Forskål).

Ageneiosus Lacepède, V, 132, 1803; type AGENEIOSUS ARMATUS Lacepède (SILURUS MILITARIS L.).

Macrorhamphosus Lacepède, V, 136, 1803; type SILURUS CORNUTUS L.

Equivalent to CENTRISCUS Cuvier, not of Linnæus.

Centranodon Lacepède, V, 138, 1803; type CENTRANODON JAPONICUS Lacepède (SILURUS IMBERBIS Houttuyn) = CALLIONYMUS INDICUS L.

Monotypic and unidentifiable, perhaps based on rough notes of PLATYCEPHALUS.

Hypostomus Lacepède, V, 144, 1803; type HYPOSTOMUS GUACARI Lacepède (LORICARIA PLECOSTOMUS L.).

Monotypic. Identical with PLECOSTOMUS Gronow.

Corydoras Lacepède, V, 147, 1803; type CORYDORAS GEOFFROY Lacepède (CATAPHRACTUS PUNCTATUS Bloch).

Tachysurus Lacepède, V, 150, 1803; type TACHYSURUS SINENSIS Lacepède.

A Chinese picture of some species of ARIUS Cuvier, which name it replaces, if identifiable.

Osmerus Lacepède, V, 229, 1803; type SALMO EPERLANUS L.

Equivalent to OSMERI L.

Coregonus Lacepède, V, 239, 1803; type SALMO LAVARETUS L.

Equivalent to COREGONI L.

Characinus Lacepède, V, 269, 1803; type SALMO GIBBOSUS L.

Equivalent to CHARACINI L. and to CHARAX Gronow, Scopoli.

Serrasalmus Lacepède, V, 283, 1803; type SALMO RHOMBEUS L.

Monotypic. Written SERRASALMO by Cuvier.

Megalops Lacepède, V, 289, 1803; type MEGALOPS FILAMENTOSUS Lacepède.

Monotypic.

Lepisosteus Lacepède, V, 331, 1803; type LEPISOSTEUS GAVIALIS Lacepède (ESOX OSSEUS L.).

Usually written LEPIDOSTEUS.

Scomberesox Lacepède, V, 344, 1803; type SCOMBERESOX CAMPERI Lacepède (ESOX SAURUS Walbaum).

Monotypic.

Aulostomus Lacepède, V, 356, 1803; type AULOSTOMUS CHINENSIS Lacepède (FISTULARIA CHINENSIS L.).

Monotypic. Usually written AULOSTOMA.

Solenostomus Lacepède, V, 360, 1803; type FISTULARIA PARADOXA Pallas.

Monotypic. Not SOLENOSTOMUS Gronow nor of Klein.

Hydrargira Lacepède, V, 378, 1803; type HYDRARGIRA SWAMPINA Lacepède (FUNDULUS MAJALIS Walbaum).

Usually written HYDRARGYRA. Monotypic. Not separable from FUNDULUS.

Stolephorus Lacepède, V, 381, 1803; type ATHERINA JAPONICA Houttuyn (SPRATELLOIDES ARGYROTÆNIA Bleeker).

Restriction of Jordan & Evermann, 1896.

The first species named by Lacepède, ATHERINA JAPONICA Houttuyn, was unknown to him, and very scantily and incorrectly described by its discoverer. Several authors—Bleeker, Jordan & Evermann—have assumed this species to be the type, and that it was congeneric with the second species named, from which Lacepède drew up his generic description and of which he gave a figure.

Study of the fauna of Nagasaki shows that no species of the modern genus STOLEPHORUS has been yet found there and that the ATHERINA JAPONICA of Houttuyn is most likely a description from rough notes or from memory of SPRATELLOIDES ARGYROTÆNIA Bleeker. ATHERINA JAPONICA was the first species to be formally named as type of STOLEPHORUS. It would have been more convenient to assume the one species known to Lacepède to be his type, reverting to the system of Bleeker, who first acted on this supposition but who named no type formally. In that case STOLEPHORUS would become the equivalent of ANCHOVIELLA Fowler, 1911. MENIDIA Browne, if available, would replace both. But it is necessary here as elsewhere to recognize the first formally stated type. If this is regarded as identifiable STOLEPHORUS replaces SPRATELLOIDES.

Mugiloides Lacepède, V, 393, 1803; type MUGILOIDES CHILENSIS Lacepède (ESOX CHILENSIS Molina).

Replaces PINGUIPES Cuv. & Val.

Chanos Lacepède, V, 395, 1803; type CHANOS ARABICUS Lacepède (MUGIL CHANOS L.).

Monotypic.

Mugilomorus Lacepède, V, 397, 1803; type MUGILOMORUS ANNA-CAROLINA Lacepède (ELOPS SAURUS L.).

Synonym of ELOPS L.

Polydactylus Lacepède, V, 419, 1803; type POLYDACTYLUS PLUMIERI Lacepède (POLYNEMUS VIRGINICUS L.).

As understood by us at present, a synonym of POLYNEMUS L.

Buro (Commerson) Lacepède, V, 421, 1803; type BURO BRUNNEUS Lacepède (TEUTHIS HEXAGONATUS Bleeker).

Monotypic. Same as SIGANUS.

Mystus Lacepède, V, 466, 1803; type MYSTUS CLUPEOIDES Lacepède (CLUPEA MYSTUS L.), a species of COILIA Gray.

The name MYSTUS is preoccupied.

Clupanodon Lacepède, V, 468, 1803; type CLUPEA THRISSA L.

As restricted by Rafinesque, 1815, through substitution for CLUPANODON the more euphonious name of THRISSA. The name CLUPANODON has been variously treated. It should properly replace KONOSIRUS Jordan & Snyder, although Lacepède's account of "CLUPANODON THRISSA" is taken mainly from the West Indian "Caillieu-Tassart," OPHISTHONEMA OGLINUM (Le Sueur), the CLUPEA THRISSA of Broussonet, but not of Linnæus.

Mene Lacepède, V, 479, 1803; type MENE ANNA-CAROLINA Lacepède (ZEUS MACULATUS Bloch), MENE MACULATA of authors.

Monotypic.

Dorsuarius Lacepède, V, 482, 1803; type DORSUARIUS NIGRESCENS Lacepède.

A species of KYPHOSUS Lacepède. Monotypic.

Xyster Lacepède, V, 484, 1803; type XYSTER FUSCUS Lacepède.

Equivalent to KYPHOSUS. Monotypic.

Cyprinodon Lacepède, V, 486, 1803; type CYPRINODON VARIEGATUS Lacepède.

Monotypic.

Muraenophis Lacepède, V, 627, 1803; type MURÆNA HELENA Lacepède.

Equivalent to MURÆNA L.

Gymnomuraena Lacepède, V, 648, 1803; type GYMNOMURÆNA DOLIATA Lacepède.

As first restricted by Kaup, 1856. Bleeker and Günther have used G. MARMORATA Lacepède as type, thus replacing UROPTERYGIUS Rüppell. A synonym of ECHIDNA.

Muraenoblenna Lacepède, V, 652, 1803; type MURÆNOBLENNA OLIVACEA Lacepède.

A synonym of MYXINE L. Monotypic.

Unibranchapertura Lacepède, V, 656, 1803; type SYMBRANCHUS MARMORATUS Bloch.

A synonym of SYMBRANCHUS.

LVII. SEWASTIANOFF, *Acarauna, Piscium Thoracices,* 1796 (1802).

Acarauna Sewastianoff, 357; type ACARAUNA LONGIROSTRIS Sewastianoff (GOMPHOSUS CÆRULEUS Lacepède).

Equivalent to GOMPHOSUS Lacepède, and apparently of later date. Not seen by us.

LVIII. COMMERSON, *Lacepède, Histoire Naturelle des Poissons,* II, 1798; III, 1800; IV, V, 1803.

PHILIBERT COMMERSON.

Commerson was an active and accurate naturalist-explorer who collected mainly in the South Seas. His specimens were accompanied by manuscript names, polynomial in form. The author had a full grasp of the meaning of "genus," as he spoke sometimes of a "genus novissimum," XYSTER, for example. Many of his generic names were adopted by Lacepède and have found their way into the system. The others are here enumerated. These have been formally accepted as eligible by the International Commission (Opinions 23 and 24 as to **Antennarius** and **Aspro**). We think that this decision might well be reconsidered as Commerson was not "binomial" and his names were not adopted by the author who first printed them as synonyms.

The names of Commerson may be ineligible as not binomial as to species and not accepted by the author who published them. Accepted provisionally by the International Commission.

Antennarius Commerson, I, 327, 1798, footnote; type ANTENNARIUS BIVERTEX TOTUS ATER PUNCTO MEDIORUM, LATERUM ALBO Commerson (in foot-note) = LOPHIUS COMMERSONIANUS Lacepède.

Equivalent to CHIRONECTES Cuvier and ANTENNARIUS Cuvier. Regarded as eligible, in Opinion 24, International Commission.

Alticus Commerson, II, 458, 1800, footnote under BLENNIUS; type ALTICUS SALTATORIUS PINNA SPURIA IN CAPITE VERTICE, BLENNIUS SALIENS Lacepède.

Accepted by Jordan & Seale, *Fishes Samoa,* 421, 1806. Equivalent to RUPISCARTES Swainson. Cuv. & Val., XI, 337, 1836, adopted the name SALARIAS ALTICUS for the BLENNIUS SALIENS, "un petit SALARIAS qui nous paraît être celui-là même pour lequel Commerson a établi son genre, ALTICUS."

Sciænus Commerson, III, footnote under CARANXOMORUS; type SCIÆNUS EX FUSCO CÆRULESCENS: CARANXOMORUS SACRESTINUS Lacepède, LABRUS FURCATUS Lacepède.

Identical with APHAREUS Cuv. & Val., the name apparently a variant of SCIÆNA. Apparently ineligible.

Naseus Commerson, III, 105, under NASO; type NASEUS FRONTICORNIS FUSCUS Commerson (CHÆTODON FRONTICORNIS L.).

Equivalent to NASO Lacepède, NASEUS Cuv. & Val.

Coryphus Commerson, III, 1802, footnote under CORYPHÆNA; **type** CORYPHUS CHRYSURUS UNDIQUE DEAURATUS etc. **Commerson,** CORYPHÆNA CHRYSURUS Lacepède, CORYPHÆNA HIPPURUS L.

Same as CORYPHÆNA.

Elops Commerson, III, 100, 1802, footnote under GOMPHOSUS; **type** GOMPHOSUS TRICOLOR Lacepède.

Equivalent to ACARAUNA Sewastianoff or to GOMPHOSUS Lacepède.

Psettus Commerson, III, 1802, footnote under MONODACTYLUS; **type** PSETTUS SPINIS PINNARUM VENTRALIUM LOCO DUABUS **Commerson** (MONODACTYLUS FALCIFORMIS Lacepède).

Revived by Cuvier & Valenciennes. A synonym of MONODACTYLUS **Lacepède.** Not PSETTUS **Klein.**

Odax Commerson, III, 1802, footnote under SCARUS; type ODAX ODON Commerson = SCARUS CHADRI Lacepède = SCARUS NIGER **Forskål.**

Monotypic. Equivalent to CALLYODON Gronow. If the names of **Commerson** are accepted, ODAX Cuvier requires a new name.

Mylio Commerson, III, 131, 1802, footnote under SPARUS; type MYLIO LINEIS LONGITUDINALIBUS PLURIBUS Commerson Ms. = SPARUS MYLIO Lacepède = CHÆTODON BIFASCIATUS Bloch.

Equivalent to SPARUS L.

Aspro Commerson, IV, 273, 1803, footnote; type ASPRO DORSO DIPTERYGIO DENTIBUS RARIS, ET LONGIS ET EXSERTIS etc. Commerson Ms. = CHEILODIPTERUS MACRODON Lacepède, as restricted by **Jordan,** Opinion 23, *Zoolgical Nomenclature,* 56, 1910.

A synonym of CHEILODIPTERUS as now restricted. Not ASPRO Cuvier.

Opisotomus Commerson, IV, 1803, footnote.

We have been unable to find this name.

Zanclus Commerson, V, 1803, footnote under CHÆTODON (**misprinted** ZANCHUS); type ZANCLUS TRANSVERSE FASCIATUS **Commerson** Ms. = CHÆTODON CORNUTUS Bloch.

Monotypic. Revived by Cuvier & Valenciennes, VII, 102, 1831.

Oculeus Commerson, V, 289, 1803, footnote under MEGALOPS; **type** OCULEUS SEU MEGALOPS POSTREMO PINNÆ etc. **Commerson** (MEGALOPS CYPRINOIDES Lacepède).

Equivalent to MEGALOPS.

Aulus Commerson, V, 1803, footnote under FISTULARIA; type **AULUS** UROGNOMON etc., FISTULARIA TABACARIA L.

Equivalent to FISTULARIA.

Encrasicholus Commerson, V, 382, 1803, footnote under CLUPEA; type ENCRASICHOLUS MANDIBULA INFERIORE BREVIORE, TÆNIA LATERALI ARGENTEA Commerson (CLUPEA VITTARGENTEA Lacepède).

Equivalent to ANCHOVIELLA Fowler (MENIDIA Browne).

Pterichthus Commerson, V, 401, 1803, footnote under EXOCŒTUS; type "PTERICHTHUS PINNIS PECTORALIBUS RADIORUM SEXDECIM VENTRALIBUS INTRA CORPORIS ÆQUILIBRIUM NEQUIDEM AD ANUM APICE PERTINGENTIBUS."

As indicated by Lacepède, this species, the one placed first by Commerson, seems to be EXOCŒTUS VOLITANS L. A synonym of EXOCŒTUS.

Halex Commerson, V, 462, 1803, footnote under CLUPEA; type HALEX CORPORE LATE CATHETEPLATEO etc. Commerson, CLUPEA FASCIATA Lacepède, a species of LEIOGNATHUS Lacepède.

LIX. PLUMIER, *Lacepède, Histoire Naturelle des Poissons,* II, 1798; III, 1800; IV, V, 1803.

CHARLES PLUMIER.

Le Père Plumier, a missionary in Martinique, sent to Lacepède numerous paintings of fishes with descriptions and manuscript names. The generic names used rest on exactly the same basis as those of Commerson. As they were polynomial and as they were not accepted by the author who published them in synonymy, we think that they should not be considered eligible in scientific nomenclature, a matter which awaits final decision.

The names probably not acceptable, as polynomial and as not adopted by the author who printed them.

Orbis Plumier, II, 504, 1800, in footnote under TETRAODON; type ORBIS MINIMUS Plumier = TETRAODON PLUMIERI Lacepède = TETRAODON SPENGLERI Bloch.

A synonym of TETRAODON.

Monoceros Plumier, II, 1800, in footnote under BALISTES; type MONOCEROS PISCIS CLUSII Plumier.

Probably same as MONACANTHUS CILIATUS L. Equivalent to MONOCANTHUS Cuvier. Not MONOCEROS Zimmermann, 1780, a genus of Gasteropods; not MONOCEROS Bloch & Schneider, 1801.

Asellus Plumier, III, 1802, footnote under GOBIOMORUS; type ASELLUS PALUSTRIS Plumier (PLATYCEPHALUS DORMITATOR Bloch & Schneider.

Identical with GOBIOMORUS Lacepède, as restricted. PHILYPNUS Cuvier.

Pelamis Plumier. III, 1802, footnote under SCOMBEROIDES; type PELAMIS MINIMA, VULGO SAUTEUR Plumier (SCOMBER SALIENS Bloch).

Identical with OLIGOPLITES Gill. Not PELAMYS Klein.

Trachurus Plumier, III, 1802, footnote under CARANXOMORUS; type TRACHURUS MAXIMUS SQUAMIS MINUTISSIMIS Plumier = CARANXOMORUS PLUMIERIANUS Lacepède = SCOMBER TRACHURUS L.

As here restricted, the same as TRACHURUS Rafinesque, 1810.

Scorpius Plumier, III, 1802, footnote under SCORPÆNA; type SCORPIUS NIGER CORNUTUS Plumier (SCORPÆNA PLUMIERI Lacepède).

The name may be available for the subgenus of SCORPÆNA, having the breast scaly (PARASCORPÆNA Bleeker). In the European type of SCORPÆNA, SCORPÆNA PORCUS L., the breast is scaleless.

Sarda Plumier, III, 141, 1802, footnote under SPARUS; type SARDA CAUDA AUREA ET LUNATA Plumier (SPARUS CHRYSURUS Bloch).

Equivalent to OCYURUS Gill. Not SARDA Cuvier, which requires a new name if the generic names of Plumier are accepted. Monotypic.

Erythrinus (ERITRINUS) Plumier, IV, 347; type ERYTHRINUS POLYGRAMMOS, MARIGNAN APUD CARAIBAS Plumier (HOLOCENTRUS SOGO Bloch).

A synonym of HOLOCENTRUS; name preoccupied. Elsewhere written ERITRINUS.

Chrysomelanus Plumier, IV, 160, 1803, footnote under SPARUS; type CHRYSOMELANUS PISCIS Plumier, SPARUS CHRYSOMELANUS Lacepède, ANTHIAS STRIATUS Bloch.

A synonym of EPINEPHELUS.

Aper Plumier, IV, 1803, footnote under SPARUS; type APER SEU TURDUS ERYTHRINUS, SQUAMIS AMPLIS Plumier (SPARUS ABILDGAARDI Lacepède).

A synonym of CALLYODON Gronow. Name preoccupied.

Guaperva Plumier, IV, footnote under SELENE; type GUAPERVA MARCGRAVII, VULGO LA LUNE Plumier (SELENE ARGENTEA Lacepède).

Identical with SELENE.

Sargus Plumier, IV, 166, footnote under DIPTERODON; type SARGUS EX AURO VIRGATUS Plumier (DIPTERODON PLUMIERI Lacepède = SPARUS SYNAGRIS L.

Same as NEOMÆNIS Girard. Not SARGUS Klein nor Cuvier. Not SARGUS Fabricius, about 1798, a genus of flies.

Pagrus Plumier, IV, 1803, footnote under BODIANUS; type PAGRUS LEUCOPHÆUS VULGO VIVANET GRIS APUD MARTINICAM Plumier = BODIANUS VIVANET Lacepède = LUTIANUS GRISEUS (L.).

Not PAGRUS Cuvier, 1817. Equivalent to NEOMÆNIS Girard; same as SALPA Catesby.

Chromis Plumier, III, 546, 1803, footnote under CHEILODIPTERUS; type CHROMIS SEU TEMBRA AUREO-CÆRULEA LITTURIS FUSCA VARIEGATA Plumier (CHEILODIPTERUS CYANOPTERUS Lacepède), the "grygry" or "grogro" of Martinique, UMBRINA COROIDES Cuv. & Val.

The name is older than UMBRINA, but later than CROMIS Browne. The specific name UMBRINA CYANOPTERA (Lacepède), based on Plumier's figure, must replace COROIDES and BROUSSONETI for this species.

Cheloniger Plumier, IV, 542, 1803, footnote under CHEILODIPTERUS; type CHELONIGER EX AURO ET ARGENTEO VIRGATUS Plumier (CHEILODIPTERUS CHRYSOPTERUS Lac. (PERCA NOBILIS L.).

The name CHELONIGER, if eligible, has priority over CONODON Cuvier.

Cephalus Plumier, V, 1803; type CEPHALUS AMERICANUS VULGO ATOULRI Plumier (MUGIL CEPHALUS L.).

A synonym of MUGIL L.

Trichis Plumier, V, 1803, footnote under CLUPEA ALOSA; type "TRICHIS BELLONII LA PUCELLE" Plumier.

Doubtful, but wrongly identified by Lacepède with CLUPEA ALOSA L.

Acus Plumier, V, 1803, footnote under SPHYRÆNA; type ACUS AMERICANA, ROSTRI LONGIORI Plumier (SPHYRÆNA ACUS Lacepède).

Same as SPHYRÆNA Röse, 1793.

LX. SHAW, *General Zoology, or Systematic Natural History*, vol. IV, 1803; vol. V, 1804.

GEORGE SHAW.

Anguilla Shaw, IV, 15, 1803; type ANGUILLA VULGARIS Shaw (MURÆNA ANGUILLA L.).

The name ANGUILLA has been ascribed to Thunberg, but we find no notice of its use as a generic term prior to Shaw.

Vandellius Shaw, IV, 199, 1803.

Needless substitute for LEPIDOPUS Gouan.

Trichopus Shaw, IV, 392, 1803; type TRICHOPUS PALLASI Shaw (LABRUS TRICHOPTERUS Pallas).

Equivalent to OSPHRONEMUS Lacepède.

Cephalus Shaw, V, 432, 1804; type DIODON MOLA L.

Equivalent to MOLA Cuvier. Not CEPHALUS Plumier.

Trachichthys Shaw, IV, 630, 1803; type TRACHICHTHYS AUSTRALIS Shaw.

Spatularia Shaw, V, 362, 1804; type SPATULARIA RETICULATA (SQUALUS SPATHULA Walbaum).
Synonym of POLYODON Lacepède.

LXI. HERRMANN, *Observationes Zoologicæ,* 1804.

JOHANN HERRMANN.

Notistium Herrmann, 305, 1804; type NOTISTIUM GLADIUS Herrmann.
Equivalent to ISTIOPHORUS Lacepède.

LXII. GIORNA, *Mémoire Sur des Poissons d'Espèces Nouvelles et de genres nouveaux*: Mémoires de l'Académie Impériale de Torino, XVI, 1803-1808.

MICHEL ESPRIT GIORNA.

Lophotes Giorna, 19, 1805; type LOPHOTES CEPEDIANUS Giorna.

Cœlorhynchus Giorna, 18, 1805; type CŒLORHYNCHUS LA VILLE Giorna.

Trachyrhynchus Giorna, 18, 1805; type (not named) LEPIDOLEPRUS TRACHYRINCUS Risso, 1810.

An earlier paper of Giorna is quoted by Dean, *Mémoire sur cinq poissons dont deux sont d'espèces nouvelles . . . et les trois autres sont de nouveaux genres:* Mém. Acad. Imp. Torino. The date of this paper is variously given. The three genera above noted were not named. Giorna would not give the nomenclature until he heard from Lacepède, to whom he had sent descriptions and drawings. The two species indicated were RAIA GIORNA Lacepède and BALISTES BUNIVA Lacepède.

LXIII. QUENSEL, *Forsäk at Narmäre Bestämma och naturligare Uppställa Svensk Arterna af Flunderslagte:* Kong. Vet. Akad. Nya Handlung, XXVII, 1806.

C. QUENSEL.

Solea Quensel, XXVII, 44, 203, 1806; type PLEURONECTES SOLEA L.

LXIV. DUMÉRIL, *Zoologie Analytique*, 1806.

ANDRÉ MARIE CONSTANT DUMÉRIL.

This work furnishes in the Index, pp. 342, 343, Latin equivalents for French vernacular names used by Lacepède, *Hist. Nat. Poiss.*, I, II, 1798, 1800. (Partly examined by us, some of the pages not verified).

Squatina Duméril, 102, 342; type (not named) SQUATINA ANGELUS Duméril (SQUALUS SQUATINA L.).

Equivalent to RHINA Klein.

Torpedo Duméril, 102, 343; type (not named) RAJA TORPEDO L.

Not TORPEDO Forskål. Same as NARCACION Klein. NARCOBATIS Blainville.

Ovoides (Lacepède) Duméril, 108, 342; type L'OVOIDE FASCÉ.

Based on a front view of TETRAODON STELLATUS L.

Equivalent to OVOIDES Cuvier and OVUM Bloch & Schneider.

Apterichthys Duméril, 112, 331; type MURÆNA CÆCA L.

Substitute for CÆCILIA Lacepède, preoccupied. A synonym of SPHAGEBRANCHUS Bloch.

Bostrichthys Duméril, 120, 332; type BOSTRYCHUS SINENSIS Lacepède.

Name a substitute for BOSTRYCHUS, preoccupied.

Spheroides (Lacepède) Duméril, 342; type "LE SPHÉROIDE TUBERCULÉ" Lacepède, 1798.

A front view of TETRAODON SPENGLERI Bloch. A synonym of TETRAODON, as restricted by Bleeker.

Macrorhynchus (Lacepède) Dumèril, 342; type "MACRORHYNQUE ARGENTÉE" Lacepède (SYNGNATHUS ARGENTEUS Osbeck).

A species near DICROTUS PROMETHEOIDES Bleeker. Probably replaces DICROTUS Günther.

LXV. DUMÉRIL, *Dictionnaire des Sciences Naturelles*, 1806.

ANDRÉ MARIE CONSTANT DUMÉRIL.

Torpedo Duméril, pl. 21; type RAJA TORPEDO L.

Not TORPEDO Forskål, 1775; replaced by NARCACION Klein or by NARCOBATIS Blainville.

LXVI. HUMBOLDT, *Ueber den Eremophilus und den Astroblepus, zwei neue Fisch-Gattungen:* Observationes Zoologicæ, and in Philos. Mag., XXIV, 1806.

ALEXANDER VON HUMBOLDT.

Eremophilus Humboldt, 17, 329; type EREMOPHILUS MUTISII Humboldt.

Astroblepus Humboldt, 19, 331; type ASTROBLEPUS GRIXALVII Humboldt.

LXVII. DUMÉRIL, *Dissertation sur les Poissons* CYCLOSTOMES, 1808.

ANDRÉ MARIE CONSTANT DUMÉRIL.

Ammocœtus Duméril; type PETROMYZON PLANERI L.

The larva of LAMPETRA FLUVIATILIS (L.) and of PETROMYZON MARINUS L. Preferably retained, under the usual spelling, AMMOCŒTES, as a designation for larval lampreys. Otherwise replaces LAMPETRA Gray, 1854; type PETROMYZON FLUVIATILIS L.

LXVIII. TILESIUS, *Descriptions de quelques Poissons*: Krusenstern's Reise um die Welt., Mem. Soc. Nat. Moscow, II, 1809.

W. G. VON TILESIUS.

Not seen by us.

Ericius Tilesius, 213, 1809; type ERICIUS (JAPONICUS Houttuyn).

A synonym of MONOCENTRIS Bloch & Schneider.

Hexagrammos (Steller) Tilesius, Actæ Academ. Petropol., II, 335, 1809; type HEXAGRAMMOS STELLERI Tilesius (HEXAGRAMMOS ASPER Tilesius).

Often written HEXAGRAMMUS.

LXIX. GEOFFROY SAINT HILAIRE, *Poissons du Nil, de la Mer Rouge et de la Méditerranée:* in Description de l'Egypte, publiée par Napoléon le Grand, Histoire Naturelle, I, 1809-1827.

ÉTIENNE FRANÇOIS GEOFFROY SAINT HILAIRE.

In this huge folio a few species of fishes are described in great detail, with steel engravings. The work is in three parts, published in 1809,

1818, and 1825, respectively, the second and third parts being prepared by Isidore Geoffroy Saint Hilaire.

Polypterus Geoffroy St. Hilaire, I, 1809; type POLYPTERUS BICHIR St. Hilaire.

LXX. PALLAS, *Labraces novum piscium genus Oceani Orientalis*: Mem. Acad. Sci. Petersb., II, 1810.

PETER SIMON PALLAS.

Labrax Pallas, II, 382, 1810; type LABRAX LAGOCEPHALUS Pallas.

Not of Klein nor of Cuvier. A synonym of HEXAGRAMMOS Steller.

LXXI. RISSO, *Ichthyologie de Nice*, 1810.

ANASTASE RISSO.

Cephalopterus Risso, 14; type RAJA GIORNA Lacepède.

Not CEPHALOPTERUS of Geoffroy St. Hilaire, 1809, a genus of birds. Equivalent to MOBULA Rafinesque.

Lepidoleprus Risso, 197; type LEPIDOLEPRUS TRACHYRHYNCHUS Risso.

A synonym of TRACHYRHYNCHUS Giorna.

Tetragonurus Risso, 347; type TETRAGONURUS CUVIERI Risso.

LXXII. RAFINESQUE, *Caratteri di Alcuni Nuovi Generi e Nuove Specie di Animale e Piante della Sicilia*, April 1, 1810.

CONSTANTINE SAMUEL RAFINESQUE-SCHMALTZ (later written simply "RAFINESQUE").

Carcharias Rafinesque, 10; type CARCHARIAS TAURUS Rafinesque.

The intended type was SQUALUS CARCHARIAS L., but C. TAURUS is the only species actually mentioned. Monotypic. Replaces ODONTASPIS Agassiz. Not CARCHARIAS Cuvier, 1817.

Dalatias Rafinesque, 10; type DALATIAS NOCTURNUS Rafinesque.

Gray in 1851 restricted DALATIAS to D. SPAROPHAGUS Rafinesque. Swainson, 1838, formally restricted DALATIAS to DALATIAS NOCTURNUS, which seems to be a species of CENTROPHORUS Müller & Henle, probably C. GRANULOSUS.

Tetroras Rafinesque, 11; type TETRORAS ANGIOVA Rafinesque.

A second-hand and erroneous description, possibly referring to CETORHINUS MAXIMUS, but unrecognizable. Monotypic.

Isurus Rafinesque, 11; type ISURUS OXYRHYNCHUS Rafinesque.
Monotypic. Replaces OXYRHINA Agassiz.

Cerictius Rafinesque, 12; type CERICTIUS MACROURUS Rafinesque.
Apparently imaginary.

Alopias Rafinesque, 12; type ALOPIAS MACROURUS Rafinesque (SQUALUS VULPINUS Bonnaterre).
Monotypic.

Heptranchias Rafinesque, 13; type SQUALUS CINEREUS Gmelin.
Monotypic.

Galeus Rafinesque, 13; type GALEUS MUSTELUS L.
As restricted by Jordan & Evermann, 1896, after Leach, 1812. Later restricted to PRISTIURUS MELASTOMUS by Garman. Not GALEUS Valmont, nor GALEUS Cuvier.
Rafinesque describes one new species of GALEUS, G. MELASTOMUS, but refers in the text to GALEUS CATULUS and GALEUS MUSTELUS. Unless GALEUS Valmont holds, in place of PRIONACE, GALEUS becomes a synonym of MUSTELUS Linck.

Hexanchus Rafinesque, 14; type SQUALUS GRISEUS L.
Monotypic. Replaces NOTIDANUS Cuvier.

Etmopterus Rafinesque, 14; type ETMOPTERUS ACULEATUS Rafinesque.
Monotypic. Replaces SPINAX Cuvier.

Rhina Rafinesque, 14; type SQUALUS SQUATINA L.
Monotypic. Identical with RHINA Klein, and SQUATINA Duméril.

Leiobatus Rafinesque, 16; type LEIOBATUS PANDURATUS Rafinesque.
Monotypic. A synonym of RHINOBATUS Linck. Not LEIOBATUS Klein.

Dipturus Rafinesque, 16; type RAJA BATIS L.
Monotypic. Identical with RAJA L.

Dasyatis Rafinesque, 16; type DASYATIS UJO Rafinesque (RAJA PASTINACA L.).
Monotypic. Identical with DASYBATUS Klein and TRYGON Adanson.

Orthragus Rafinesque, 17; type TETRAODON MOLA L.
Monotypic. Equivalent to MOLA Kœlreuter.

Diplanchias Rafinesque, 17; type DIPLANCHIAS NASUS Rafinesque.
Monotypic. Equivalent to MOLA.

Typhle Rafinesque, 18; type TYPHLE HEXAGONUS Rafinesque (SYNGNATHUS TYPHLE L.).
Misspelled TIPHLE. Preoccupied by TYPHLE * Lacepède, 1800, a genus of mammals. Replaced by TYPHLINUS Rafinesque, 1815, and by SIPHONOSTOMUS Kaup. Monotypic.

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* Under the head of CÆCILIA, Lacepède refers to its alleged blindness, a character almost unknown among vertebrates. "Parmi lesquels on ne connoît encore qu'un mammifère, nommé TYPHLE, et le genre des cartilagineux nommés GASTROBRANCHES qui aient paru complètement aveugles."

Siphostoma Rafinesque, 18; type SYNGNATHUS PELAGICUS L.

Monotypic. A synonym of SYNGNATHUS L. as the latter is now restricted.

Hippocampus Rafinesque, 18; type SYNGNATHUS HIPPOCAMPUS L. (HIPPOCAMPUS HEPTAGONUS Rafinesque).

Oxyurus Rafinesque, 19; type OXYURUS VERMIFORMIS Lacepède.

A larva, probably of CONGER.

Scarcina Rafinesque, 20; type SCARCINA ARGYREA Rafinesque.

A synonym of LEPIDOPUS Gouan.

Luvarus Rafinesque, 22; type LUVARUS IMPERIALIS Rafinesque.

Monotypic.

Bothus Rafinesque, 23; type, as restricted, BOTHUS RUMOLO Rafinesque (PLEURONECTES RHOMBUS L.).

Equivalent to RHOMBUS Klein, of earlier date.

Corystion Rafinesque, 24; type CORYSTION MUSTAZOLA Rafinesque.

Some species of TRACHINUS L. Monotypic.

Merluccius Rafinesque, 25; type GADUS MERLUCIUS L. (MERLUCCIUS SMIRIDUS Rafinesque).

Monotypic.

Phycis Rafinesque, 26; type PHYCIS PUNCTATUS Rafinesque.

Not PHYCIS Fabricius, 1798, a genus of Butterflies. Equivalent to PHYCIS Röse, 1793, which is not preoccupied.

Oxycephas Rafinesque, 31; type OXYCEPHAS SCABRUS Rafinesque.

A species of TRACHYRHYNCHUS Giorna, 1805. Monotypic.

Lepimphis Rafinesque, 33; type LEPIMPHIS HIPPUROIDES Rafinesque (CORYPHÆNA HIPPURUS L.).

Identical with CORYPHÆNA.

Symphodus Rafinesque, 41; type SYMPHODUS FULVESCENS Rafinesque = LUTIANUS ROSTRATUS Bloch = LABRUS SCINA Forskål.

Replaces CORICUS Cuvier.

Trachurus Rafinesque, 41; type SCOMBER TRACHURUS L. (TRACHURUS SAURUS Rafinesque).

By general usage and by tautonomy.

Tricropterus Rafinesque, 41; type by definition, SCOMBER CARANGUS Bloch (SCOMBER HIPPOS L.).

Not separable from CARANX; no species named.

Hypodis Rafinesque, 41; type SCOMBER GLAUCUS L.

Equivalent to GLAUCUS Klein; not separable from CÆSIOMORUS Lacepède.

Centracanthus Rafinesque, 42 (misprinted CENTRACANTUS); type CENTRACANTUS CIRRUS Rafinesque (SMARIS INSIDIATOR Cuv. & Val.).

Monotypic; probably a specimen with the dorsal fin torn. This seems to be generically different from SPICARA Rafinesque, SMARIS Cuvier. Afterwards spelled CENTRACANTHA.

Hypacanthus Rafinesque, 43 (misprinted HYPACANTUS); type "SCOMBER ACULEATUS L."

But there is no such species of Linnæus. Rafinesque elsewhere identifies it with CENTRONOTUS VADIGO Lacepède, which is the type of CAMPTOGRAMMA Regan, 1903. This name must be replaced by HYPACANTHUS.

Naucrates Rafinesque, 43; type NAUCRATES FANFARUS Rafinesque (GASTEROSTEUS DUCTOR L.).

Replaces CENTRONOTUS Lacepède, preoccupied.

Notognidion Rafinesque, 46; type NOTOGNIDION SCIRENGA Rafinesque.

Unidentified. Monotypic.

Spicara Rafinesque, 51; type SPICARA FLEXUOSA Rafinesque (SPARUS SMARIS L.).

Equivalent to SMARIS Cuvier and having priority. Monotypic.

Aylopon Rafinesque, 52; type LABRUS ANTHIAS L.

A substitute for ANTHIAS Bloch, said to be preoccupied. We do not find it so.

Lopharis Rafinesque, 52; type PERCA LOPHAR Forskål.

Identical with POMATOMUS Lacepède. Monotypic.

Lepterus Rafinesque, 52; type LEPTERUS FETULA Rafinesque (STROMATEUS FIATOLA L.).

Identical with STROMATEUS L. Monotypic.

Gonenion Rafinesque, 53; type GONENION SERRA Rafinesque (PERCA LOPHAR Forskål).

Identical with POMATOMUS Lacepède. Monotypic.

Lepodus Rafinesque, 53; type LEPODUS SARAGUS Rafinesque (SPARUS RAII Bloch).

Monotypic. Equivalent to BRAMA Bloch & Schneider, not of Klein. Replaces BRAMA Cuvier, if Klein's names are eligible.

Tetrapturus Rafinesque, 54; type TETRAPTURUS BELONE Rafinesque.

Argyctius Rafinesque, 55; type ARGYCTIUS QUADRIMACULATUS Rafinesque.

Equivalent to TRACHYPTERUS Gouan.

Tirus Rafinesque, 56; type TIRUS MARMORATUS Rafinesque (ESOX SYNODUS L.).

Equivalent to SYNODUS.

Lucius Rafinesque, 59; type ESOX LUCIUS L. (LUCIUS VORAX Rafinesque).

The author attempts to limit the name ESOX to ESOX BELONE L., and its allies, an arrangement not accepted by the International Commission, (Opinion 58).

Sudis Rafinesque, 60; type SUDIS HYALINA Rafinesque.

Monotypic.

Sayris Rafinesque, 60; type SAYRIS RECURVIROSTRA Rafinesque (ESOX SAURUS Walbaum).

A needless substitute for SCOMBERESOX.

Cogrus Rafinesque, 62; type COGRUS MACULATUS Rafinesque.

COGRUS is a tenable subgenus of OPHICHTHUS.

Piescephalus Rafinesque, 63; type PIESCEPHALUS ADHERENS Rafinesque (LEPADOGASTER GOUANI Gouan).

A synonym of LEPADOGASTER Gouan.

Echelus Rafinesque, 63; type by first restriction (Bleeker, *Atlas Ichth., Muræn.*, p. 30) ECHELUS PUNCTATUS Rafinesque (MURÆNA MYRUS L.).

Identical with MYRUS Kaup, 1856. Restricted later by Jordan & Evermann to species of CONGER, but the earliest arrangement must hold.

Nettastoma Rafinesque, 66; type NETTASTOMA MELANURA Rafinesque.

Monotypic.

Dalophis Rafinesque, 68; type DALOPHIS SERPA Rafinesque (SPHAGEBRANCHUS IMBERBIS De la Roche, 1809).

Equivalent to CÆCULA Vahl.

LXXIII. RAFINESQUE, *Indice d'Ittiologia Siciliana,* May, 1810.

CONSTANTINE SAMUEL RAFINESQUE-SCHMALTZ.

Onus Rafinesque, 12; type ONUS RIALI Rafinesque (GADUS MERLUCCIUS L.).

A needless substitute for MERLUCCIUS.

Merolepis Rafinesque, 25; type SPARUS MASSILIENSIS Lacepède (SPARUS ZEBRA Brünnich).

Probably a genus distinct from MÆNA Cuvier.

Gaidropsarus Rafinesque, 11, 51; type GAIDROPSARUS MUSTELLARIS Rafinesque (GADUS MUSTELA L.).

Antedates MOTELLA Cuvier. Monotypic.

Strinsia Rafinesque, 12, 51; type STRINSIA TINCA Rafinesque.

Monotypic.

Symphurus Rafinesque, 13, 52; type SYMPHURUS NIGRESCENS Rafinesque.

Antedates APHORISTIA Kaup, but not PLAGUSIA Browne.

Solea Rafinesque, 14, 52; type SOLEA BUGLOSSA Rafinesque (PLEURONECTES SOLEA L.).

Equivalent to SOLEA Quensel.

Scophthalmus Rafinesque, 14, 53; type PLEURONECTES RHOMBUS L.

As later restricted, identical with BOTHUS Rafinesque and RHOMBUS Klein. SCOPHTHALMUS is based on descriptions, BOTHUS on specimens of the same two species.

Diplodus Rafinesque, 26, 54; type SPARUS ANNULARIS L.

Equivalent to SARGUS Cuvier and prior, but not prior to SARGUS Klein.

Octonus Rafinesque, 29, 54; type OCTONUS OLOSTEON Rafinesque (TRIGLA CATAPHRACTA L.).

Monotypic. Equivalent to PERISTEDION Lacepède.

Cephalepis Rafinesque, 31, 54; type CEPHALEPIS OCTOMACULATUS Rafinesque.

A synonym of REGALECUS Ascanius. Monotypic.

Myctophum Rafinesque, 35, 56; type MYCTOPHUM PUNCTATUM Rafinesque.

Nerophis Rafinesque, 37, 57; type SYNGNATHUS OPHIDION L.

Monotypic.

Carapus Rafinesque, 37, 57; type GYMNOTUS ACUS L.

Prior to FIERASFER Cuvier. Not CARAPUS Cuvier = GITON Kaup.

Sturio Rafinesque, 41, 58; type STURIO VULGARIS Rafinesque (ACIPENSER STURIO L.).

Capriscus Rafinesque, 41, 58; type CAPRISCUS PORCUS Rafinesque (BALISTES CAPRISCUS Gmelin, "the third division of Lacepède").

Equivalent to BALISTES L.

Chlopsis Rafinesque, 42, 58; type CHLOPSIS BICOLOR Rafinesque.

Monotypic.

Xypterus Rafinesque, 43, 59; type XYPTERUS IMPERATI Rafinesque.

Apparently a synonym of REGALECUS Ascanius. Monotypic.

Pterurus Rafinesque, 43, 59; type PTERURUS FLEXUOSUS Rafinesque (SPHAGEBRANCHUS IMBERBIS De la Roche).

Name preoccupied: a synonym of CÆCULA Vahl.

Oxynotus Rafinesque, 45, 60; type SQUALUS CENTRINA L.

Prior to CENTRINA Cuvier, 1817.

Sphyrna Rafinesque, 46, 60; type SQUALUS ZYGÆNA L.

Prior to ZYGÆNA Cuvier.

Torpedo Rafinesque, 48, 60; type TORPEDO OCELLATA Rafinesque (RAJA TORPEDO L.).

Not TORPEDO Forskål.

Mobula Rafinesque, 48, 61; type MOBULA AURICULATA Rafinesque (RAJA MOBULAR Lacepède).

Same as CEPHALOPTERUS Risso, preoccupied.

Cephaleutherus Rafinesque, 48, 61; type CEPHALEUTHERUS MACULATUS Rafinesque.

Apparently a deformed RAJA. Monotypic.

Uroxis Rafinesque, 48, 61; type UROXIS UJUS Rafinesque (RAJA PASTINACA L.).

Monotypic. Equivalent to DASYATIS Rafinesque.

Apterurus Rafinesque, 48, 62; type APTERURUS FABRONI Rafinesque.

Equivalent to MOBULA Rafinesque.

Oxystomus Rafinesque, 49, 62; type OXYSTOMUS HYALINUS Rafinesque, larva of OPHISURUS SERPENS (L.).

A synonym of OPHISURUS Lacepède.

Helmictis Rafinesque, 49, 62; type HELMICTIS PUNCTATUS Rafinesque, 1810.

Probably a species of CÆCULA. Monotypic.

Epigonus Rafinesque, 64; type EPIGONUS MACROPHTHALMUS Rafinesque.

Equivalent to POMATOMUS Cuvier, not of Lacepède. Monotypic.

Gonostoma Rafinesque, 64; type GONOSTOMA DENUDATUM Rafinesque.

Monotypic.

Merlangus Rafinesque, 67; type GADUS MERLUCIUS L.

A needless substitute for ONUS and MERLUCCIUS.

LXXIV. STELLER in *Tilesius*: Mem. Acad. Sci., Petersburg, 1811.

GEORG WILHELM STELLER.

Myoxocephalus Steller, in *Tilesius*, IV, 273; type MYOXOCEPHALUS STELLERI Tilesius.

LXXV. PALLAS, *Zoographia Rosso-Asiatica*, III, 1811.

PETER SIMON PALLAS.

This important work was printed and partly distributed in 1811, the bulk of the edition being withheld until 1831.

Phalangistes Pallas, 113; type COTTUS CATAPHRACTUS L.

As restricted by Jordan & Evermann. Also written PHALANGISTA. Not PHALANGISTA Cuvier, 1800, a genus of mammals. Equivalent to AGONUS Lacepède.

Elæorhoüs Pallas, 122; type CALLIONYMUS BAICALENSIS Pallas.

A synonym of COMEPHORUS Lacepède.

Gasteracanthus Pallas, 228; type GASTERACANTHUS CATAPHRACTUS Pallas.

Equivalent to GASTEROSTEUS L.

Coracinus Pallas, 256; type CORACINUS CHALCIS Pallas (SCIÆNA NIGRA Bloch).

Equivalent to CORVINA Cuvier, 1829. Not CORACINUS Gronow, which is DIPTERODON Cuvier.

Lebius (Steller Ms.) Pallas, 279; type LABRAX SUPERCILIOSUS Pallas, "LEBIUS, CHIRUS VEL LABRAX Steller, Mss. Obs. Ichthyol."

These three names are indicated in Steller's unprinted manuscripts as words from which choice could be made.

Chirus (Steller Ms.) Pallas, 279; type LABRAX SUPERCILIOSUS Pallas.

Like the preceding synonym of LABRAX or HEXAGRAMMOS.

Plagyodus (Steller Ms.) Pallas, 383; type PLAGYODUS Steller (ALEPISAURUS ÆSCULAPIUS Bean).

Equivalent to ALEPISAURUS Lowe, 1833, the name used by Steller only in an oblique case, "PLAGYODONTEM" and without specific name.

LXXVI. LEACH, *Observations on the genus* SQUALUS, 1812.

WILLIAM E. LEACH.

Mustelus Leach, 62; type SQUALUS MUSTELUS L.

LXXVII. MONTAGU, *Wernerian Museum*, I, 1812.

GEORGE MONTAGU.

Xipotheca Montagu, I, 82; type XIPOTHECA TETRADENS Montagu = LEPIDOPUS CAUDATUS (Euphrasen).

A synonym of LEPIDOPUS.

LXXVIII. FISCHER, *Zoognosia, Tabulis Synopticus Illustrata*, Edition III, vol. I, 1813.

GOTTHELF FISCHER.

A series of Analytical Keys, leading to genera only.

Histrio Fischer, 70, 78; type (not named) LOPHIUS HISTRIO L., by tautonomy.

Diagnosis erroneous, by misprint "corpus depressum" instead of "corpus compressum." Has precedence over PTEROPHRYNE Gill and PTEROPHRYNOIDES Gill.

Ogcocephalus Fischer, 70, 78; type not named; evidently by definition, LOPHIUS VESPERTILIO L.

Replaces MALTHE Cuvier.

Orbis (Lacepède) Fischer, 70; no type named.

Said to be like DIODON but "ad minus 4 dentes in maxilla superiore." Evidently a misprint for "2 dentes." It is probably a synonym of OVOIDES Cuvier, the presumable type being TETRAODON LINEATUS L., the "ORBIS" of Salviani and Rondelet.

Odontolepis Fischer, 71, 78; no type named.

A flounder with "pinnæ pectorales tenuissimæ aut nullæ, reliquis conjunctis." The type may be assumed as SYMPHURUS NIGRESCENS. A synonym of SYMPHURUS Rafinesque, 1810. Perhaps species of MONOCHIRUS or MICROCHIRUS were included.

Psilus Fischer, 74.

A substitute for BOSTRYCHUS Lacepède, which is preoccupied. Equivalent to BOSTRICHTHYS Duméril.

Psiloides Fischer, 74.

A needless substitute for BOSTRYCHOIDES Lacepède.

Typhlotes Fischer, 75.

A substitute for CÆCILIA Lacepède, preoccupied. A synonym of SPHAGEBRANCHUS Bloch.

Mustellus Fischer, 78; type (not named) SQUALUS MUSTELUS L.

A synonym of MUSTELUS Linck, not of Valmont.

LXXIX. FISCHER, *Recherches Zoologiques:* Mémoires de la Société Impériale des Naturalistes de Moscou, IV, second edition, 1813.

Eleginus Fischer, 252; type GADUS NAVAGA Kœlreuter.

Replaces TILESIA Swainson, 1839 (preoccupied) and PLEUROGADUS Bean, 1885. Not ELEGINUS Cuv. & Val., 1830, which becomes ELEGINOPS Gill.

LXXX. LEACH, *Zoological Miscellany,* 1814.

WILLIAM E. LEACH.

Hippocampus Leach, 103; type SYNGNATHUS HIPPOCAMPUS L. (HIPPOCAMPUS ANTIQUORUM Leach).

Same as HIPPOCAMPUS Rafinesque, 1810.

LXXXI. MITCHILL, *Report in Part on the Fishes of New York*, 1814.

SAMUEL LATHAM MITCHILL.

Stomodon Mitchill, 7; type STOMODON BILINEARIS Mitchill.

Equivalent to MERLUCCIUS Rafinesque.

Morone Mitchill, 18; type MORONE PALLIDA Mitchill (PERCA AMERICANA Gmelin).

As restricted by Gill, 1860.

Tautoga Mitchill, 23; type TAUTOGA NIGER Mitchill (LABRUS ONITIS L.).

Roccus Mitchill, 25; type ROCCUS STRIATUS Mitchill (SCIÆNA LINEATA Bloch).

As restricted by Gill.

LXXXII. RAFINESQUE, *Descrizione di un Nuovo Genere di Pesce*: Specchio delle Scienze, Palermo, 1814.

CONSTANTINE SAMUEL RAFINESQUE.

Leptopus Rafinesque, I, 16; type LEPTOPUS PEREGRINUS Rafinesque.

Monotypic. Name preoccupied and later changed to PODOLEPTUS Rafinesque, 1815. Apparently a synonym of LOPHOTES Giorna.

LXXXIII. RAFINESQUE, *Descrizione di un Nuovo Genere di Pesce Siciliano:* Specchio delle Scienze, II, 1815.

Nemochirus Rafinesque, II, 100, 105; type NEMOCHIRUS ERYTHROPTERUS Rafinesque.

Unrecognized.

The following is Rafinesque's account of this fish:

NEMOCHIRUS. Corpo lanceolato compressissimo ensiforme, fronte diagonale, bocca dentata, un' ala dorsale longitudinale senza raggi sciolti, ala caudale sciolta, nessun' ala anale, le due ale pettorali filiformi avvicinate e situate sotto la gola al posto delle ventrali.

NEMOCHIRUS ERYTHROPTERUS. Corpo argentato, ale rosse, coda lunulata, con un raggio intermedio mucronato sciolto lunghissimo e filiforme, tre macchie fosche da ogni lato del dorso.

Descrizione. Lunghezza totale due palmi, muso ottuso, mascella inferiore più corta con denti acuti, occhi piccoli neri, iride grande argentina con un cerchio rosso esteriore, opercolo doppio: corpo d'un bel colore argenteo, con tre macchie irregolari fosche di ogni lato del dorso, linea laterale dritta, ventre un poco reti-

colato. Ale pettorali rosse lineari-filiformi acute e con un solo raggio, ala dorsale rossa principiando sopra gli occhi e giungendo sino alla coda, della quale è però staccata e con circa 200 raggi molli: coda rossa un poco trifida o quasi lunulata con però il raggio intermedio semplice, sporgente lunghissimo, mentre i laterali sono ramosi con i rami opposti.

We are indebted to Mr. H. M. Scudder for a copy of this rare and forgotten description. If this account is correct it is still unknown to science, though having much in common with STYLEPHORUS CORDATUS Shaw.

LXXXIV. RAFINESQUE, *Précis des Découvertes Somiologiques,* 1814.

Trisopterus Rafinesque, 16; type GADUS CAPELANUS Lacepède (GADUS MINUTUS L.).

According to Risso the name is synonymous with MORUA Risso, and must be older. Equivalent to BRACHYGADUS Gill.

Monochirus Rafinesque; type MONOCHIRUS HISPIDUS Raf.

LXXXV. RAFINESQUE, *Analyse de la Nature, ou Tableau de l'Univers et des Corps Organisés "La Nature est mon Guide et Linneus mon maître."* Palermo, 1815.

In this work the entire animal and plant kingdoms are classified, with definitions of the families and higher groups and lists of the known genera. Three hundred and seventy-seven genera of fishes are enumerated. Many of these are bare names, without explanation of any sort. Others represent changes of names of genera for reasons not expressed, but apparently because current names were too long, too short, or involved a termination (OIDES, OMORUS) expressing resemblance. The fishes are divided into two subclasses, HOLOBRANCHIA with opercles and gill membranes complete, and ATELOSIA, lacking either opercles or gill membranes.

The HOLOBRANCHIA are divided into DERIPIA (Jugulares), GASTRIPIA (Abdominales), THORAXIPIA (Thoracices), APODIA (Apodes).

The ATELEOSIA are divided into ELTROPOMIA (Sturgeons: Sternoptyx, Pegasus) with one opercle and no gill membrane; CHISMOPNEA, with gill-membranes and one opercle (Chimæra, Balistes, Conger, etc.); and TREMAPNEA, with neither opercles nor gill membranes (eels and sharks).

This classification is singularly inept.

Dactyleptus Rafinesque, 82.

Substitute for MURÆNOIDES Lacepède.

Pholidus Rafinesque, 82.

A synonym of PHOLIS Scopoli. Substitute for ENCHELYOPUS Gronow.

Pteraclidus Rafinesque, 82.

Substitute for OLIGOPODUS Lacepède. A synonym of PTERACLIS Gronow.

Pacamus, 82; nomen nudum.

Ictius, 82, "sp. do."

That is, based on species of the preceding, *i. e.*, PACAMUS.

Dropsarus, 82.

Evidently an emendation of GAIDROPSARUS Rafinesque.

Trisopterus, 82.

Brosme, 82.

Batrichtius, 82.

A substitute for BATRACHOIDES Lacepède.

Ceracantha, 82.

Taunis, 82.

Plagiusa, 83, "sp. do."

That is, species of PLEURONECTES; apparently based on PLEURONECTES PLAGIUSA L., thus equivalent to SYMPHURUS Rafinesque, 1810.

Holacantha, 83.

Substitute for HOLACANTHUS Lacepède.

Pomacantha, 83.

Nasonus, 83.

Substitute for NASO Lacepède.

Alectis, 84.

Substitute for GALLUS Lacepède, which is preoccupied, leaving ALECTIS as valid.

Bostrictis, 84.

Substitute for BOSTRYCHUS Lacepède: a synonym of BOSTRICHTHYS Duméril, 1806.

Pterops, 84, 90.

Substitute for BOSTRYCHOIDES Lacepède.

Tasica, 84.

Nemipus, 84.

Cephalepis, 84.

Gymnurus, 84.

Substitute for TÆNIOIDES Lacepède.

Polipturus, 84.
Substitute for Scomberomorus Lacepède.

Orcynus, 84.
Substitute for Scomberoides Lacepède.

Baillonus, 85.
Substitute for Cæsiomorus Lacepède.

Lepicantha, 85.
Apparently shortened from Lepisacanthus Lacepède.

Gastrogonus, 85.

Cephimmus, 85.
Substitute for Gymnocephalus Bloch.

Lepipterus, 85.

Panotus, 85.
Substitute for Tænionotus Lacepède.

Aylopon, 85.
Substitute for Anthias Bloch.

Lopharis, 85.

Cephacandia, 85.
Substitute for Cephalacanthus Lacepède.

"Gonurus Lac.," 85.
Unexplained; no such name appears in Lacepède.

Lepomus, 86.

Pomagonus, 86.

Mesopodus, 86.

Acaramus, 86.

Clodipterus, 86, also on 88.
Substitute for Cheilodipterus Lacepède.

Macrolepis, 86, "sp. do."
That is, of Apogon Lacepède.

Guebucus, 86.

Micropodus, 86.
Substitute for Cheilio Lacepède.

Megaphalus, 86.
Substitute for Gobiesox Lacepède.

Pomacanthis, 86.

Oxima, 86.

Equetus, 86.
Substitute for Eques Bloch.

Branchiostegus, 86.
Substitute for CORYPHÆNOIDES Lacepède, not of Gunner. **Replaces LATILUS** Cuv. & Val., 1830.

"**Eleotris** Gr., GOBIOMORUS Lacepède," 86.

Epiphthalmus, 86.
Substitute for GOBIOMOROIDES Lacepède.

Lepimphis, 86.

Plecopodus, 87.
Substitute for GOBIOIDES Lacepède.

Piescephalus, 87.

Lumpus, 87, "sp. do."
That is, of CYCLOPTERUS.

Liparius, 87, "sp. do."
That is, of CYCLOPTERUS.

Percis Scopoli, 87.
Said to be same as ASPIDOPHOROIDES Lacepède.

Aygula, 87.
Substitute for CORIS Lacepède.

Octonus, 88.

Gasterodon, 88.

Xysterus, 88.
For XYSTER Lacepède.

Meneus, 88.
For MENE Lacepède.

Buronus, 88.
For BURO Lacepède.

Thrissa, 88.
Substitute for CLUPANODON Lacepède.

Megalops, 88.

Prinodon, 88.
Substitute for CYPRINODON Lacepède.

Maturacus, 88.

Edomus, 88.

Gonipus, 88.

Myxonum, 88.
Substitute for MUGILOIDES Lacepède.

Trichonotus, 88.
Substitute for MUGILOMORUS Lacepède.

Soranus, 88.

Cordorinus, 89.

Substitute for CORYDORAS Lacepède.

Amiatus, 89.

Substitute for AMIA L. AMIATUS becomes eligible if AMIA Gronow be accepted instead of APOGON.

Sayris, 89.

Substitute for SCOMBRESOX Lacepède.

Ramphistoma, 89; "Raf. BELONE Gronow."

The word BELONE was not used in a generic sense by Gronow, but first by Cuvier in 1817. Rafinesque apparently refers to synonymy of the species as quoted from Gronow by Lacepède.* This reference does not seem to justify the substitution of RAMPHISTOMA for BELONE.

Odumphus, 89.

Onopionus, 89.

Guaris, 90.

Typhlinus, 90, "sp. do."

That is, of SYNGNATHUS, earlier called TYPHLE by Rafinesque, which name is used by Lacepède for a "blind" genus of mammals, but without mention of type.

Phyllophorus, 90.

Homolenus, 90.

This and the two preceding are placed in the same family as SYNGNATHUS.

Goniodermus, 90, "sp. do."

Of OSTRACION.

Cephalopsis, 90, "sp. do."

Of DIODON.

Orbidus, 90.

For "SPHEROIDE" of Lacepède.

Oonidus, 90.

For "OVOIDE" of Lacepède.

Tangus, 91.

Said to be the same as "HEPTACA" Rafinesque.

Piratia, 91.

Opictus, 91.

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*In the synonymy of ESOX BELONE Lacepède has this quotation:

"*Belone* et *raphis*, id est *acus*. Petri Artedi Synonymia Piscium etc., auctore J. G. Schneider, etc.

"Gronov. Mus. 1, n. 39. Zooph., p. 117, n. 362."

In a hasty reading, Rafinesque must have ascribed both sentences to Gronow, who apparently did not use the name BELONE.

Ictiopogon, 91.
Substitute for Bostrychus Lacepède, which is preoccupied.

Dameus, 91.

Neleus, 91.

Nemochirus, 91.

Dipinotus, 91.

Symphocles, 91.
This and the preceding are placed near Trichiurus.

Melanictis, 92.

Epimonus, 92, "sp. do."
That is, of Balistes, doubtless intended for Monacanthus.

Lophidius, 92.
Variant of Lophius.

Chironectes, "R", 92, "sp. do."
Of Lophius.

Conomus, 92, "sp. do."
Of Lophius.

Branderius, 93.
Substitute for Cæcilia Lacepède, a synonym of Sphagebranchus Bloch.

Anopsus, 93.
Substitute for Murænoblenna Lacepède.

Gymnopsis, 93.
Substitute for Gymnomuræna Lacepède.

Helmictis, 93.

Rincoxis, 93.

Zebricium, 93.

Pterurus, 93.

Sphyrnias, 93.
Variant of Sphyrna Rafinesque.

Platopterus, 93.
Substitute for Raja L.

Epinotus, 93.

Lymnea, 93.

Podoleptus, 93.
Substitute for Leptopus Rafinesque, 1814. A synonym of Lophotes Giorna.

Megaderus, 93.
Substitute for Echidna Forster.

Ictætus, 93.

Sephenia, 93.

Megabatus, 93.

Apturus, 93.

Lampreda, 94, "sp. do."
Of PETROMYZON.

Pricus, 94, "sp. do."
Of PETROMYZON. This and the preceding doubtless equivalent to AMMOCŒTES Duméril and LAMPETRA Gray, the former based on the larval state of lampreys.

LXXXVI. CUVIER, *Observations et Recherches Critiques sur differens Poissons de la Méditerrannée, et à leur Occasion sur des Poissons d'autres mers plus ou moins Liés avec Eux:* Mémoires du Museum d'Histoire Naturelle, Paris, I, 1815.

GEORGES LÉOPOLD CHRÉTIEN FRÉDÉRIC DAGOBERT CUVIER.

Glossodus Cuvier, I, 1815; type ARGENTINA GLOSSODONTA Forskål.
Same as ALBULA Gronow, BUTYRINUS Lacepède.

Fierasfer Cuvier, I, 119, 312, 359, 1815; type OPHIDION IMBERBE L.
Same as CARAPUS Rafinesque. (Name in French only; dates from Oken, 1817.)

Xyrichthys Cuvier, I, 317, 329, 355, 1815; type XYRICHTHYS CULTRATUS Cuvier (CORYPHÆNA NOVACULA L.).

Epibulus Cuvier, I, 111; type SPARUS INSIDIATOR Pallas.

Smaris Cuvier, I, 111; type SPARUS SMARIS L.

Myletes Cuvier, I, 115; type MYLETES RHOMBOIDALIS Cuv.

Saurus Cuvier, I, 115; type SALMO SAURUS L.

Chromis Cuvier, 393; type SPARUS CHROMIS L.
Monotypic. Same as HELIASES Cuvier, 1817.

Crenilabrus Cuvier, 357; type LABRUS LAPINA Forskål (Les Crénilabres).
Bonaparte, in 1839, named as type C. PAVO, which is the same as C. LAPINA. Name in French only, dates from Oken, 1817.

Corycus Cuvier, 359; type (not otherwise named) LUTIANUS ROSTRATUS Bloch.
Based on "les deux derniers Lutjans de M. Risso." Called CORICUS by Cuvier in 1817. A synonym of SYMPHODUS Rafinesque.

Tetragonopterus Cuvier, ~~I, 114;~~ type T. ARGENTEUS Cuvier.

Les Serrans Cuvier.

This is not a scientific name. Reference is made to ANTHIAS SACER Bloch.

Diacope Cuvier, 360; type HOLOCENTRUS BENGALENSIS Bloch.

Name preoccupied, replaced by GENYOROGE Cantor, 1850.

Diagramma Cuvier, 360; type ANTHIAS DIAGRAMMA Bloch.

A synonym of PLECTORHINCHUS Lacepède.

Scolopsis Cuvier, 361; type the CURITE of Russell (SCOLOPSIS CURITE Cuvier).

Les Priacanthes Cuvier, 361; type ANTHIAS MACROPHTHALMUS Bloch.

First called PRIACANTHUS by Cuvier in 1817.

Les Pristipomes Cuvier, 361; type LUTIANUS HASTA Bloch.

Called PRISTIPOMUS by Oken in 1817. A synonym of POMADASYS Lacepède.

Julis Cuvier, 362; type LABRUS JULIS L.

By tautonomy and by first restriction.

Boops Cuvier, 453; type SPARUS BOOPS L.

By tautonomy. Later called Box Cuvier.

The genus SPARUS L. is divided into Sargues, SPARUS SARGUS L.; Daurades, SPARUS AURATA L.; and Pagres, SPARUS PAGRUS L. No Latin names are indicated and no type assigned to SPARUS L. "Les Canthères" is a name assigned (p. 485) to SPARUS CANTHARUS L.

Dentex Cuvier, 486; type SPARUS DENTEX L.

By tautonomy,

Les Melettes, 457; type CLUPEA BRÜNNICHI Gmelin.

This group is equivalent to ENGRAULIS Cuvier, 1817. No Latin name is assigned.

On page 14 of this volume the name SCIÆNA UMBRA L., originally based on two species (the "Maigre" and the "Corb," confounded by Linnæus), is definitely restricted to the first of these, the CHEILODIPTERUS AQUILA of Lacepède. This species then becomes the type of SCIÆNA, replacing ARGYROSOMUS DE LA PYLAIE and PSEUDOSCIÆNA Bleeker. The "Corb" remains as CORVINA NIGRA (Bloch).

LXXXVII. BLAINVILLE, *Prodrome d'Une Nouvelle Distribution Systématique du Règne Animal:* Bullétin de la Société Philomatique, 1816.

HENRI MARIE DUCROTAY DE BLAINVILLE.

Descriptions of the genera indicated appeared also in the *Fauna Française,* 1820-1830.

The pagination as here given is taken from Garman, *Plagiostomia,* 1913.

Trygonobatus Blainville, 112; type RAIA PASTINACA L.

Equivalent to DASYATIS Rafinesque.

Aetöbatus Blainville, 112; type RAJA NARINARI Euphrasen.

As restricted by Müller & Henle, 1838; not as restricted by Cantor, 1850. The latter arrangement would accord better with Blainville's obvious purpose of making RAJA AQUILA his "AETOBATIS VULGARIS," the best known of these "raies aigles," his type. The first restriction, however, has the sanction of Agassiz, Günther, and Gill.

Dicerobatus Blainville, 116; type RAJA MOBULAR Lacepède.

A synonym of MOBULA Rafinesque. Monotypic.

Leiobatus Blainville, 121, "Raies lisses"; type LEIOBATUS SLOANI Blainville.

A species of UROTRYGON. Not LEIOBATUS Rafinesque, which is RHINOBATUS; nor LEIOBATUS Klein, a synonym of RAJA.

Narcobatus Blainville, 121; type RAJA TORPEDO L.

Scylliorhinus Blainville, 121, "SQUALES ROUSSETTES"; type SQUALUS CANICULA Lacepède.

As restricted. Prior to SCYLLIUM Cuvier.

Cestrorhinus Blainville, 121; type SQUALUS ZYGÆNA L.

A synonym of CESTRACION Klein and SPHYRNA Rafinesque.

Monopterhinus Blainville, 121, "squales à une seule pinnule dorsale"; type SQUALUS GRISEUS Gmelin.

A synonym of HEXANCHUS Rafinesque. Monotypic.

Acanthorhinus Blainville, 121, "squales épineux"; type SQUALUS ACANTHIAS Lacepède.

Equivalent to SQUALUS L. as restricted by Rafinesque and by Gill.

Heterodontus Blainville, 121; type SQUALUS PHILIPPI Lacepède.

The name seems sufficiently different from HETERODON, a genus of snakes of prior date, although from identical Greek roots. Otherwise would stand as CENTRACION Gray. Monotypic.

Cetorhinus Blainville, 121; type SQUALUS MAXIMUS Gunner.

Monotypic.

Galeorhinus Blainville, 121, "Squales demi-Requins"; type SQUALUS CANIS L.

As restricted by Gill, 1864; SQUALUS MUSTELUS as restricted by Garman, 1913. The former arrangement must hold, replacing EUGALEUS Gill.

Carcharhinus Blainville, 121; type SQUALUS COMMERSONIANUS Blainville.

As restricted by authors.

Echinorhinus Blainville, 121, "Squales bouclés"; type SQUALUS SPINOSUS Gmelin.

Monotypic.

LXXXVIII. CUVIER, *Sur le genre* CHIRONECTES Cuv. (ANTENNARIUS Commerson): Mém. du Mus., III, 1817.

GEORGES CUVIER.

Chironectes Cuvier, 418; type LOPHIUS COMMERSONIANUS Lacepède.

LXXXIX. CUVIER, HYDROCYON, CHALCEUS etc.: Mémoires du Museum, IV, 1817; V, 1819.

Hydrocyon Cuvier, V, 353, 1819; type HYDROCYON FORSKALI Cuvier ("Les Hydrocyns," I, 115).

Myletes Cuvier, IV, 449, 1817; type MYLETES RHOMBOIDALIS Cuvier.

Tetragonopterus (Artedi) Cuvier, IV, 455, 1817; type TETRAGONOPTERUS ARGENTEUS Cuvier.

Chalceus Cuvier, IV, pl. XXI, 1817, V, 351; type CHALCEUS MACROLEPIDOTUS Cuvier.

XC. LE SUEUR, *A new genus of Fishes proposed under the name of* CATOSTOMUS: Journ. Acad. Nat. Sci. Phila., I, 1817.

CHARLES A. LE SUEUR.

Catostomus Le Sueur, 88; type CYPRINUS CATOSTOMUS Forster (CATOSTOMUS HUDSONIUS Le Sueur).

XCI. CUVIER, *Règne Animal*, Ed. 1, 1817. *Le Règne Animal Distribué d'Après son Organisation.* Tome II, 1817 (Reptiles, Fishes, etc.).

GEORGES CUVIER.

This epoch-making work marks the advent of the modern epoch in zoological taxonomy. The entire animal kingdom is considered, its families and genera are all defined, and the entire system is placed on the sound basis of comparative anatomy.

In a number of cases the genera in this work receive French names only. But to all these, Latin forms were immediately supplied in the same year, 1817, by Oken, in the *Isis*.

Ammocœtes (Duméril) Cuvier, 119; type PETROMYZON BRANCHIALIS L.

The larval form of PETROMYZON and LAMPETRA.

Scyllium Cuvier, 124; type SQUALUS CANICULA L.

As restricted. A synonym of SCYLLIORHINUS Blainville, 1816.

Carcharias Cuvier, 125; type SQUALUS CARCHARIAS.

As shown in the figure of Bélon, 60. "Cette figure de Bélon est la seule bonne. La plupart des autres sont fausses." Equivalent to CARCHARHINUS Blainville. Not CARCHARIAS Rafinesque, 1810.

Lamna Cuvier, 126; type SQUALUS CORNUBICUS Bloch & Schneider (SQUALUS NASUS Bonnaterre).

Zygæna Cuvier, 127; type SQUALUS ZYGÆNA L.

Equivalent to CESTRACION Klein, SPHYRNA Rafinesque.

Galeus Cuvier, 127; type SQUALUS GALEUS L.

Not GALEUS Valmont, nor of Klein, nor of Rafinesque. Equivalent to GALEORHINUS Blainville. Monotypic.

Mustelus Cuvier, 128; type SQUALUS MUSTELUS L.

Equivalent to MUSTELUS Linck.

Notidanus Cuvier, 128; type SQUALUS GRISEUS L.

Monotypic. Equivalent to HEXANCHUS Rafinesque, 1810.

Selache Cuvier, 129; type SQUALUS MAXIMUS L.

Equivalent to CETORHINUS Blainville, 1816. Monotypic.

Cestracion Cuvier in Oken, 129, ("Les Cestracions" Cuvier); Oken,* *Isis*, 1183; type SQUALUS PHILIPPI Bloch & Schneider.

Equivalent to HETERODONTUS Blainville, 1816. Not CESTRACION Klein.

Spinax Cuvier, 129; type SQUALUS SPINAX L.

Equivalent to ETMOPTERUS Rafinesque, 1810.

Centrina Cuvier, 130; type SQUALUS CENTRINA L.

Equivalent to OXYNOTUS Rafinesque, 1810.

Scymnus Cuvier, 130; type SQUALUS AMERICANUS Gmelin.

Monotypic. Preoccupied by SCYMNUS Kugelmann, 1814, a genus of Beetles; replaced by SCYMNORHINUS Bonaparte, 1846.

DALATIAS Rafinesque may be the same.

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*Oken, *Isis*, 1817. In *Isis*, 1817, immediately following the publication of the *Règne Animal*, Professor L. Oken recapitulated the genera of Cuvier, giving Latin forms to those left by the author with French names only. These occur on pages 1181, 1182, and 1183 (misprinted in the text as 1781, 1782, and 1783). Several of these were also Latinized by Cloquet, *Dictionnaire d'Histoire Naturelle*, in 1817, but the date of Oken is earlier. Still others were Latinized by John Stark, *Elements of Natural History, Edinburgh*, 1828, vol. I.

As the question of priority is not affected, we leave the names of Cuvier latinized by Oken in their proper sequence.

Trygon Adanson in Cuvier, 136; type RAJA PASTINACA L.

This name, quoted from Adanson's Manuscript *Cours d'Histoire Naturelle*, in 1772, has been adopted by several authors. TRYGON appears also as a new genus (equivalent to TÆNIURA) of Geoffroy St. Hilaire in the *Histoire d'Egypte*, with the date of 1825. The name is certainly later than DASYBATUS of Klein, with the same type, and also later than DASYATIS Rafinesque.

Callorhynchus (Gronow) Cuvier, 140; type CHIMÆRA CALLORHYNCHUS L.

Monacanthus (Cuvier) Oken, 152, ("Les Monacanthes" Cuvier); type BALISTES CHINENSIS Bloch.

Alutera (Cuvier) Oken, 153, ("Les Alutères" Cuvier); type BALISTES MONOCEROS L.

Triacanthus (Cuvier) Oken, 153, ("Les Triacanthes" Cuvier); type BALISTES BIACULEATUS Bloch.

Monotypic.

Hippocampus Cuvier, 157; type SYNGNATHUS HIPPOCAMPUS L.

Equivalent to HIPPOCAMPUS Rafinesque.

Characinus Cuvier, 164; no type named.

Equivalent to CHARACINI L., CHARAX Gronow.

Curimatus (Cuvier) Oken, 165, ("Les Curimates" Cuvier); type SALMO EDENTULUS Bloch (SALMO CYPRINOIDES L.).

Name latinized as CURIMATUS Oken, 1182, as CURIMATA by Cloquet. Equivalent to CURIMATA Walbaum, 1792.

Anostomus (Gronow) Cuvier, 165; type SALMO ANOSTOMUS L.

Called LEPORINUS by Cuvier & Valenciennes.

Piabucus (Cuvier) Oken, 166, ("Les Piabuques" Cuvier); type SALMO ARGENTINUS Bloch.

Latinized as PIABUCUS by Oken, as PIABUCA by Müller & Tröschel.

Citharinus Cuvier, 168; type "LE SERRASALME CITHARINE" Geoffroy.

CYTHARINUS Oken, 1182, ("Les Citharines" Cuvier, 1815, I. 115).

Saurus Cuvier, 169; type SALMO SAURUS L.

Scopelus Cuvier, 169; type GASTEROPELECUS HUMBOLDTI Risso.

Equivalent to MYCTOPHUM Rafinesque, 1810.

Aulopus Cuvier, 170; type SALMO FILAMENTOSUS Bloch.

Engraulis Cuvier, 174; type CLUPEA ENCRASICHOLUS L.

Thrissa Cuvier, 176; type CLUPEA SETIROSTRIS Broussonet.

Equivalent to MYSTUS Lacepède, preoccupied. Not THRISSA Rafinesque. Later spelled THRYSSA by Cuvier.

This genus or subgenus may receive a new name, THRISSOCLES Jordan & Evermann, type CLUPEA SETIROSTRIS Broussonet. It is distinguished from MENIDIA Browne or ANCHOVIELLA Fowler, by the greatly prolonged maxillary.

Pristigaster Cuvier, 176; type not named.

Later fixed as PRISTIGASTER CAYANUS Cuvier.

Chirocentrus Cuvier, 178; type ESOX CHIROCENTRUS L. (CLUPEA DORAB Gmelin).

Sudis Cuvier, 180; type (not named) SUDIS GIGAS Cuvier.

Equivalent to ARAPAIMA Müller and Troschel, 1846 (VASTRES Valenciennes, 1846).

Not SUDIS Rafinesque, 1810.

Galaxias Cuvier, 183; type ESOX TRUTTACEUS Cuvier.

Monotypic.

Microstoma Cuvier, 184; type GASTEROPELECUS MICROSTOMUS Risso.

Monotypic.

Stomias Cuvier, 184; type ESOX BOA Risso.

Monotypic.

Salanx Cuvier, 185; type (not named) SALANX REEVESI Cuv. & Val. (ALBULA CHINENSIS Osbeck).

Monotypic. Synonym of ALBULA Osbeck, if the latter name is regarded as eligible.

Belone Cuvier, 185; type ESOX BELONE L.

Hemi-Ramphus Cuvier, 186; type ESOX BRASILIENSIS L.

Barbus Cuvier, 192; type CYPRINUS BARBUS L.

Gobio Cuvier, 193; type CYPRINUS GOBIO L.

Not GOBIO of Klein, which is identical with GOBIUS L. If Klein's names are accepted, GOBIO Cuvier, based on the common gudgeon of Europe, CYPRINUS GOBIO L., must receive a new name.

Tinca Cuvier, 193; type CYPRINUS TINCA L.

Cirrhinus (Cuvier) Oken, 193, ("Les Cirrhines" Cuvier); type CYPRINUS CIRRHOSUS Bloch.

The name is spelled CIRRHINA by Valenciennes.

Abramis Cuvier, 194; type CYPRINUS BRAMA L.

Equivalent to BRAMA Klein, not of Cuvier.

Labeo Cuvier, 194; type CYPRINUS NILOTICUS (Forskål) Geoffroy.

Not LABEO Bowdich, 1825.

Leuciscus (Klein) Cuvier, 194; type CYPRINUS LEUCISCUS (L.) Bloch.

Identical with LEUCISCUS Klein.

Lebia (Cuvier) Oken, 199, ("Les Lebias" Cuvier), Oken, *Isis*, 1183; type CYPRINODON VARIEGATUS Lacepède.

Monotypic. Identical with CYPRINODON Lacepède, 1803. Written LEBIAS by Cuvier.

Schilbe (Cuvier) Oken, 202, ("Les Schilbe" Cuvier), Oken, *Isis*, **1182;** type SILURUS MYSTUS Hasselquist.

Synodontis Cuvier, 203; type PIMELODUS SYNODONTIS Geoffroy.

Bagre (Cuvier) Oken, 204, ("Les Bagres" Cuvier), Oken, *Isis*, 1182; type SILURUS BAGRE L.

By tautonomy. Latinized as BAGRUS by Valenciennes. This generic name must replace FELICHTHYS Swainson and AILURICHTHYS Baird, for the Gaff-topsail Cat-fish FELICHTHYS MARINUS (L), of American waters, unless the earlier name BAGRE of Catesby, applied to another genus, be deemed eligible. The name BAGRUS, transferred by Cuvier & Valenciennes to another part of the same group of "Bagres," may be replaced by PORCUS Geoffroy, 1817, as BAGRUS is only a variant spelling of BAGRE.

Morrhua (Cuvier) Oken, ("Les Morues"), 212, 1182; type GADUS MORRHUA L.

Same as GADUS L.

Merlangus (Cuvier) Oken, ("Les Merlans"), 213, 1182; type GADUS MERLANGUS L.

Not MERLANGUS Rafinesque, 1810.

Lota (Cuvier), ("Les Lottes") Oken, 215, 1182; type GADUS LOTA Bloch.

By tautonomy.

Mustela (Cuvier), ("Les Mustèles") Oken, 215, 1182; type GADUS MUSTELA L.

Preoccupied in Mammals: replaced by MOTELLA Cuvier, 1829. Synonym of GAIDROPSARUS Raf.

Brosme (Cuvier), ("Les Brosmes") Oken, 216, 1182; type GADUS BROSME Gmelin.

Called BROSMIUS by Cuvier, 1829.

Raniceps (Cuvier) Oken, 217, ("Les Raniceps" Cuvier), Oken, 1182; type GADUS RANINUS Müller.

Platessa Cuvier, 220; type PLEURONECTES PLATESSA L.

Equivalent to PLEURONECTES as restricted by Fleming.

Hippoglossus Cuvier, 221; type PLEURONECTES HIPPOGLOSSUS L.

Rhombus Cuvier, 222; type PLEURONECTES RHOMBUS Cuvier.

Equivalent to RHOMBUS Klein, not of Lacepède. Name used in Mollusks, RHOMBUS Da Costa, 1776. Same as BOTHUS Rafinesque.

Solea Cuvier, 223; type PLEURONECTES SOLEA L.

Equivalent to SOLEA Quensel and SOLEA Rafinesque.

Monochirus (Cuvier) Oken, 223, ("Les Monochires" Cuvier), MONOCHIRUS Oken, 1182; type PLEURONECTES MICROCHIRUS De la Roche.

Monotypic. Equivalent to Rafinesque.

Plagusia (Browne) Cuvier, 224; type PLEURONECTES PLAGUSIA L.

Equivalent to PLAGUSIA Browne, not of Latreille, 1806, a genus of CRUSTACEANS.

Lumpus (Cuvier) Oken, 226, ("Les Lumps" Cuvier) Oken, 1182; type CYCLOPTERUS LUMPUS L.

Equivalent to CYCLOPTERUS L.

Conger (Cuvier) Oken, 231, ("Les Congres" Cuvier), Oken, 1182; type MURÆNA CONGER L.

Equivalent to CONGER Houttuyn.

Alabes (Cuvier) Oken, 235, ("Les Alabes" Cuvier), Oken, 1182; type (not named) CHEILOBRANCHUS DORSALIS Richardson.

Said to be identical with CHEILOBRANCHUS Richardson, 1848, which it replaces.

Carapus Cuvier, 237; type GYMNOTUS MACROURUS Bloch.

Not CARAPUS Rafinesque, 1810. The name is written CARAPO by Oken. Replaced by GITON Kaup.

Fierasfer (Cuvier) Oken, 239, ("Les Fierasfers" Cuvier) Oken, 1182; type OPHIDIUM IMBERBE L.

Equivalent to CARAPUS Rafinesque, 1810. Monotypic.

Lophotes (Giorna) Cuvier, 243, ("Les Lophotes" Cuvier), the name written LOPHOTUS by Oken, 1182; type "le Lophote Lacepède" Giorna (LOPHOTES CEPEDIANUS).

Monotypic.

Clinus Cuvier, 251; type BLENNIUS SUPERCILIOSUS L.

Pholis (Artedi) Cuvier, 251; type BLENNIUS PHOLIS Bloch.

Not PHOLIS Gronow.

Salarias Cuvier, 251; type SALARIAS QUADRIPENNIS Cuvier.

Opistognathus (Cuvier) Oken, 252, ("Les Opisthognathes" Cuvier), Oken, 1182; type OPISTHOGNATHUS SONNERATI Cuvier.

Monotypic.

Sillago Cuvier, 258; type SILLAGO ACUTA Cuvier.

Julis Cuvier, 261; type LABRUS JULIS L.

This name has been unfortunately transferred by later writers to a great group of the tropical seas, THALASSOMA Swainson.

Crenilabrus Cuvier, 262, ("Les Crenilabres" Cuvier), Oken, 1182; type LABRUS LAPINA Forskål.

Valenciennes makes the type LABRUS PAVO Risso; but that species is not mentioned by Cuvier, although identical with L. LAPINA.

Bonaparte, in 1839, named as type C. PAVO, which is the same as C. LAPINA. In 1839, just previous, Swainson observes: "M. Cuvier having expressly stated

that the type of his genus CRENILABRUS is the LUTJANUS VERRES of Bloch, I have so retained it, placing all the others under the subgenus CYNÆDUS."

L. VERRES is identical with the type of BODIANUS Bloch. We find no such statement in Cuvier's writings, and L. VERRES is ninth of his original species. CYNÆDUS Swainson, as restricted by Bonaparte, is identical with CTENOLABRUS Cuv. & Val.

In the *Fauna Italica*, 156, 1839, Bonaparte assigned types to certain genera of Labroid fishes. LABRUS GUTTATUS Bloch was indicated as type of HEMIULIS Swainson; LABRUS VETULUS Bloch is considered as type of LABRUS L. This name, VETULUS, was not used by Linnæus, but it is a synonym of LABRUS BIMACULATUS L. and LABRUS MIXTUS L. LABRUS BIMACULATUS may thus be regarded as the type of LABRUS. LABRUS RUPESTRIS Bloch is indicated as type of CYNÆDUS Swainson. This becomes a synonym of CTENOLABRUS Cuv. & Val., of a little earlier date in 1839. LABRUS PAVO of authors, not of Linnæus, is recognized by Bonaparte as type of CRENILABRUS. This species is not named by Cuvier, but it is identical with LABRUS LAPINA Forskål, a species included by Cuvier. In Swain's excellent review of Swainson (1882) the type of each genus is indicated. The type of HEMIULIS (AURATUS) assigned by Swain is a species of CHEILIO Lacepède. The type of CYNÆDUS is C. TINCA = C. DODERLEINI Jordan, not LABRUS TINCA L., a species of CRENILABRUS. Bonaparte's selection of types has, however, priority over Swain's. Bonaparte and Swainson recognize LABRUS JULIS L. as type of JULIS. The same type, as LABRUS PAVO Hasselquist, is assigned to CHLORICHTHYS Swainson by Bonaparte. Swain makes the latter a synonym of THALASSOMA Swainson. Bonaparte, 1846, selected L. JULIS L. as type of ICHTHYCALLUS Swainson, reducing both CHLORICHTHYS and ICHTHYCALLUS to the synonymy of JULIS.

Coricus Cuvier, 263; type LUTIANUS VIRESCENS Risso (L. ROSTRATUS Bloch).

Equivalent to SYMPHODUS Rafinesque.

Epibulus Cuvier, 264; type SPARUS INSIDIATOR Pallas.

Monotypic.

Novacula Cuvier, 265; type CORYPHÆNA NOVACULA L.

By tautonomy. Afterwards restricted by Cuvier & Valenciennes to CORYPHÆNA PENTADACTYLA Lacepède, the genus HEMIPTERONOTUS Lacepède.

A synonym of XYRICHTHYS Cuvier, 1815.

Chromis (Cuvier) Oken, 266, ("Les Chromis" Cuvier), Oken, 1182; type SPARUS CHROMIS Lacepède.

Not CROMIS Browne, 1770, nor CHROMIS Cuvier, 1815. Called HELIASES by Cuvier & Valenciennes.

Plesiops (Cuvier) Oken, 266; type not named.

Afterwards described as PLESIOPS NIGRICANS Rüppell. Equivalent to PHAROPTERYX Rüppell, 1828.

Smaris Cuvier, 269; type SPARUS SMARIS L.

A synonym of SPICARA Rafinesque.

Boops Cuvier, 270; type SPARUS BOOPS L.

Later called Box Cuv. & Val.

Sargus Cuvier, 272; type SPARUS SARGUS L.

Equivalent to SARGUS Klein and DIPLODUS Rafinesque.

Aurata (Cuvier) Oken, 272, ("Les Daurades" Cuvier), Oken, 1183; type SPARUS AURATA L.

Equivalent to SPARUS L., as restricted by Fleming. Later called CHRYSOPHRYS by Cuvier.

Pagrus Cuvier, 272; type SPARUS ARGENTEUS Bloch & Schneider (SPARUS PAGRUS L.).

Not PAGRUS Plumier.

Dentex Cuvier, 273; type SPARUS DENTEX L.

Diacope Cuvier, 275; type DIACOPE SEBÆ Cuvier.

Name preoccupied in butterflies (DIACOPE Hübner, 1816); replaced by GENYOROGE Cantor, 1850. Equivalent to NAQUA Forskål, 1775, a name doubtfully eligible.

Serranus Cuvier, 276, ("Perche de mer ou serran"); type PERCA CABRILLA L. ("le Serran proprement dit").

SERRANUS CABRILLA is usually assumed as the type of the genus SERRANUS, and therefore of the family SERRANIDÆ. But no species of the genus as thus restricted is mentioned by Cuvier by scientific name. Cuvier, however, remarks: "La Méditerranée en produit beaucoup dont les plus communs s'y confondent sous les noms vulgaires de PERCHE DE MER, de SERRAN, etc." This refers to SERRANUS CABRILLA and SERRANUS SCRIBA. The first of these may be retained as type, following general custom, although its scientific name is not mentioned. Otherwise HOLOCENTRUS GIGAS Bloch & Schneider, which is explicitly mentioned, must be taken, in which case SERRANUS disappears, as a synonym of EPINEPHELUS Bloch, and the name SERRANELLUS Jordan & Eigenmann, a sub-generic term for SERRANUS SCRIBA, would stand for the genus, as in Fowler's arrangement (Proc. Ac. Nat. Sci. Phila., 1907, 266).

Plectropomus (Cuvier) Oken, 277, ("Les Plectropomes" Cuvier), PLECTROPOMUS Oken, 1182, PLECTROPOMA of Cuv. & Val.; type as restricted BODIANUS MACULATUS Bloch.

Cantharus Cuvier, 278; type SPARUS CANTHARUS L. ("Les Canthares," 1815.)

Name preoccupied; replaced by SPONDYLIOSOMA Cantor, 1850.

Pristipomus (Cuvier) Oken, 279, ("Les Pristipomes" Cuvier), Oken, 1182, (PRISTIPOMA of Cuvier & Valenciennes); type LUTJANUS HASTA Bloch.

Equivalent to POMADASYS Lacepède.

Scolopsis Cuvier, 280; type "le Kurite, Russell" (SCOLOPSIDES KURITA Cuv. & Val.).

Called SCOLOPSIDES by Cuvier.

Diagramma (Cuvier) Oken, 280, ("Les Diagrammes" Cuvier), Oken, 1183; type ANTHIAS DIAGRAMMA Bloch.

Equivalent to PLECTORHYNCHUS Lacepède.

Anabas Cuvier, 339; type PERCA SCANDENS Daldorf.
Monotypic.

Fiatola Cuvier, 342; type STROMATEUS FIATOLA L.
Equivalent to STROMATEUS L.

Seserinus (Cuvier) Oken, 342, ("Les Seserinus" Cuvier); type "SESERINUS Rondelet" (SESERINUS RONDELETI Cuvier).
This is apparently a young STROMATEUS, MICROCHIRUS (Bonelli).

Premnas Cuvier, 345; type CHÆTODON BIACULEATUS Bloch.
Monotypic.

Temnodon Cuvier, 346; type CHEILODIPTERUS HEPTACANTHUS Lacepède.
Monotypic. Equivalent to POMATOMUS Lacepède. The name POMATOMUS was arbitrarily transferred to a different genus (EPIGONUS Raf.) by Cuvier.

Amphisile (Klein) Cuvier, 350; type CENTRISCUS SCUTATUS L.
Equivalent to CENTRISCUS L. and AMPHISILEN Klein.

XCII. OKEN, *Isis*, 1817.

L. OKEN.

On pages 1182-83 (misprinted 1782-83), Professor Oken gives Latin equivalents to all the French names in the first edition of the *Règne Animal* of Cuvier, as indicated above.

XCIII. CLOQUET, *Dictionnaire des Sciences Naturelles de Levrault* (Articles on Fishes), 1816 to 1830.

HIPPOLYTE CLOQUET.

(Latinizes several of Cuvier's names, as previously done by Oken.)

Zingel Cloquet, 1817; "les cingles" Cuvier, called ZINGEL by Oken; type PERCA ZINGEL L.

Eptatretus (Duméril) Cloquet, XV, 134, 1819; type GASTROBRANCHUS DOMBEY Lacepède.
Replaces HEPTATREMA Duméril and BDELLOSTOMA Müller.

XCIV. GEOFFROY ST. HILAIRE, *Suite de l'Histoire des Poissons du Nil,* Plates dated 1817, 1818.

ISIDORE GEOFFROY ST. HILAIRE.

Porcus Geoffroy St. Hilaire, 303, 1818; type SILURUS BAJAD Forskål.

Equivalent to BAGRUS Cuv. & Val. but not to "les Bagres" Cuvier, 1817, BAGRE Oken. PORCUS should probably replace BAGRUS, which is a latinization of BAGRE, the vernacular Spanish name for the larger cat-fishes.

Heterobranchus Geoffroy St. Hilaire, 305, 1818; type HETEROBRANCHUS BIDORSALIS Geoffroy St. Hilaire.

XCV. LE SUEUR, *Description of Several New Species of North American Fishes*: Jour. Ac. Nat. Sci. Phila., 1818.

CHARLES A. LE SUEUR.

Somniosus Le Sueur, *222*; type SOMNIOSUS BREVIPINNA Le Sueur, SQUALUS MICROCEPHALUS Bloch & Schneider.

Platirostra Le Sueur, 223; type PLATIROSTRA EDENTULA Le Sueur.

Same as POLYODON.

Hiodon Le Sueur, 366; type HIODON TERGISUS Le Sueur.

Often spelled HYODON.

XCVI. RANZANI, *Descrizione di un Pesce, un Nuovo Genere dei Tænioidei:* Opusculo Sci. Bologna, II, 1818.

CAMILLO RANZANI.

Epidesmus Ranzani, 133; type EPIDESMUS MACULATUS Ranzani.

Synonym of REGALECUS.

XCVII. BLAINVILLE, *Poissons Fossiles*: Nouveau Dictionnaire, XXVII, 1818.

HENRI MARIE DUCROTAY DE BLAINVILLE.

Not seen by us.

Anenchelum Blainville; type ANENCHELUM GLARISIANUM Blainville (fossil: LEPIDOPIDÆ).

Anabas Cuvier, 339; type PERCA SCANDENS Daldorf.
Monotypic.

Fiatola Cuvier, 342; type STROMATEUS FIATOLA L.
Equivalent to STROMATEUS L.

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Synonym of REGALECUS.

XCVII. BLAINVILLE, *Poissons Fossiles*: Nouveau Dictionnaire, XXVII, 1818.

HENRI MARIE DUCROTAY DE BLAINVILLE.

Not seen by us.

Anenchelum Blainville; type ANENCHELUM GLARISIANUM Blainville (fossil: LEPIDOPIDÆ).

Chirurgus Blainville; type (perhaps Chætodon chirurgus Bloch).

Not seen by us: probably a synonym of Hepatus and Teuthis.

Palæoniscum Blainville, 320; type Palæoniscum frieslebenense Blainville (fossil).

Written Palæoniscus by Agassiz.

Palæothrissum Blainville, 320; type Palæothrissum macrocephalum Blainville (fossil).

Synonym of Palæoniscum.

Palæorhynchum Blainville, XXVII, 314, 1818; type Palæorhynchum glarisianum Blainville.

Palæobalistum Blainville, 338; type Diodon orbicularis Volta (fossil).

XCVIII. RAFINESQUE, *Description of two new Genera of North American Fishes,* Opsanus *and* Notropis: American Monthly Magazine and Critical Review, January 1818.

Constantine Samuel Rafinesque.

Opsanus Rafinesque, 203; type Opsanus cerapalus Raf. (Gadus tau L.).

This genus has been usually and wrongly called Batrachus.

Notropis Rafinesque, 204; type Notropis atherinoides Raf. (Alburnus rubellus Agassiz).

XCIX. RAFINESQUE, *Discoveries in Natural History*: American Monthly Magazine, September 1818.

Glossodon Rafinesque, 354; type Glossodon harengoides Raf. (Hiodon tergisus Le Sueur).

A synonym of Hiodon, regarded by Rafinesque as too "similar to Diodon in sound."

C. RAFINESQUE, *Further Discoveries in Natural History*: Amer. Monthly Magazine, October 1818.

Pogostoma Rafinesque, 445; type Pogostoma leucops Rafinesque.

A myth drawn by Audubon.

Dinectus Rafinesque, 445; type Dinectus truncatus Raf.

A mythical sturgeon, drawn by Audubon.

Litholepis Rafinesque, 445; type LITHOLEPIS ADAMANTINUS Raf.

The "Devil-jack Diamond Fish," drawn by Audubon, a mythical gar-pike of which the scales will "turn a rifle ball."

This remarkable paper is based on paintings of fishes "seen down the river" by Audubon. Rafinesque was, in 1818, a guest at Audubon's house at Hendersonville, Kentucky. One night, bats entered the window. Rafinesque was convinced that they were of a new species, and used Audubon's costly violin to beat them down. Audubon in return showed him paintings of remarkable fishes. Rough copies of these are found in Rafinesque's note-books, preserved in the Smithsonian Institution. Their introduction into Science was a practical joke on the part of the great ornithologist.

Rafinesque also mentions as new genera, by name only, without explanation: CHEILOBUS, MINICULUS, OPLICTIS, LEPTOSOMA and GLANIS. These can have no place in the system.

CI. RAFINESQUE, *Description of Three New Genera of Fluviatile Fish,* POMOXIS, SARCHIRUS *and* EXOGLOSSUM: Jour. Ac. Nat. Sci. Phila., November 1818.

Pomoxis Rafinesque, 417; type POMOXIS ANNULARIS Raf.

Sarchirus Rafinesque, 419; type SARCHIRUS VITTATUS Raf.

Young of LEPISOSTEUS OSSEUS.

Exoglossum Rafinesque, 421; type EXOGLOSSUM ANNULATUM Raf. (CYPRINUS MAXILLINGUA Le Sueur).

Maxillingua Rafinesque, 421; type CYPRINUS MAXILLINGUA Le Sueur.

Same as EXOGLOSSUM.

Hypentelium Rafinesque, 421; type EXOGLOSSUM MACROPTERUM Raf. (CATOSTOMUS NIGRICANS Le Sueur).

Replaces HYLOMYZON Agassiz.

CII. RAFINESQUE, *Further account of Discoveries etc.*: Amer. Monthly Magazine, November 1818.

Noturus Rafinesque, 41; type NOTURUS FLAVUS Raf.

CIII. RAFINESQUE, *Prodrome de 70 Nouveaux Genres et d'Animaux Découverts dans l'intérieur des États Unis d'Amérique durant l'Année 1818:* Journal de Physique, de Chymie et d'Histoire Naturelle, Paris, June 1819.

Aplodinotus Rafinesque, 419; type APLODINOTUS GRUNNIENS Raf.

Spelling corrected by Gill to HAPLOIDONOTUS.

Etheostoma Rafinesque, 419; type ETHEOSTOMA BLENNIOIDES Raf.

As determined by Agassiz. Later fixed on ETHEOSTOMA FLABELLARIS Rafinesque by Jordan & Evermann. Replaces DIPLESION Rafinesque and HYOSTOMA Agassiz.

Leucops Rafinesque, 419; type POGOSTOMA LEUCOPS Raf.

A myth of Audubon.

Aplocentrus Rafinesque, 420; type APLOCENTRUS CALLIOPS Raf.

Mythical; after Audubon.

Calliurus Rafinesque, 420; type CALLIURUS PUNCTULATUS Raf.

A synonym of MICROPTERUS Lacepède.

Lepomis Rafinesque, 420; type, as stated by the author, LABRUS AURITUS L.

Pomotis Rafinesque, 420; type also stated to be LABRUS AURITUS L.

Apomotis Rafinesque, 420; type LEPOMIS CYANELLUS Raf.

Notemigonus Rafinesque, 421; type NOTEMIGONUS AURATUS Raf. (CYPRINUS CRYSOLEUCAS Mitchill).

Amphiodon Rafinesque, 421; AMPHIODON ALVEOIDES Raf. (Misprint for ALOSOIDES.)

Replaces ELATTONISTIUS Gill & Jordan.

Amblodon Rafinesque, 421; type AMBLODON BUBALUS Raf.

The "Buffalo-fish," to which the large blunt pharyngeal teeth of APLODINOTUS were wrongly ascribed. A complex; the name AMBLODON later restricted by Rafinesque to APLODINOTUS GRUNNIENS, while the Buffalo-fish became type of ICTIOBUS Rafinesque.

Cycleptus Rafinesque, 421; type CYCLEPTUS NIGRESCENS (CATOSTOMUS ELONGATUS Le Sueur).

Pilodictis Rafinesque, 422; type PILODICTIS LIMOSUS Raf.

A myth.

CIV. RAFINESQUE, *Annals of Nature*, I, 1820.

Hemiplus Rafinesque, 6; type HEMIPLUS LACUSTRIS Raf. (CYPRINUS CRYSOLEUCAS Mitchill).

Same as NOTEMIGONUS Rafinesque, 1819.

CV. RAFINESQUE, *Ichthyologia Ohiensis*, 1820.

It was the fortune of Professor Rafinesque to be one of the first to explore two of the richest fish faunas of the world, that of Sicily and that of the Ohio River. His various papers show his peculiar traits, intense activity, keen philosophical insight, and hopeless slovenliness in method.

Stizostedion Rafinesque, 23; type PERCA SALMONEA Raf. (PERCA VITREA Mitchill).

Lepibema Rafinesque, 23; type PERCA CHRYSOPS Raf.

Pomacampsis Rafinesque, 23; type PERCA NIGROPUNCTATA Raf.
Mythical, being one of Audubon's practical jokes.

Ichthelis Rafinesque, 27; type LABRUS AURITUS L.
A needless substitute for LEPOMIS, which is transferred (p. 30) to species of MICROPTERUS Lacepède.

Telipomis Rafinesque, 27; type LEPOMIS CYANELLUS Raf.
A needless substitute for APOMOTIS.

Aplites Rafinesque, 30; type LEPOMIS PALLIDA Raf.
A species of MICROPTERUS.

Nemocampsis Rafinesque, 30; type LEPOMIS FLEXUOLARIS Raf.
A species of MICROPTERUS.

Dioplites Rafinesque, 32; type LEPOMIS NOTATA Raf.
Also a synonym of MICROPTERUS.

Ambloplites Rafinesque, 33; type LEPOMIS ICHTHELOIDES Raf. (BODIANUS RUPESTRIS Raf., 1817).

Aplesion Rafinesque, 36; type ETHEOSTOMA CALLIURA Raf.
The young of MICROPTERUS.

Diplesion Rafinesque, 37; type ETHEOSTOMA BLENNIOIDES Raf.
A synonym of ETHEOSTOMA Raf. See opinion 14, Comm. Zool. Nomenc.

Pomolobus Rafinesque, 38; type POMOLOBUS CHRYSOCHLORIS Raf.

Dorosoma Rafinesque, 39; type DOROSOMA HETERURA Raf. (MEGALOPS CEPEDIANA Le Sueur).

Clodalus Rafinesque, 43; type HIODON CLODALUS Le Sueur.
Same as HIODON.

Minnilus Rafinesque, 45; type MINNILUS DINEMUS Raf.
This is apparently the same as NOTROPIS Raf., 1818.

Dobula Rafinesque, 45; type not named (CYPRINUS DOBULA L.).
Equivalent to LEUCISCUS Cuvier.

Phoxinus Rafinesque, 45; type not named (CYPRINUS PHOXINUS L.).

Alburnus Rafinesque, 45; type not named (CYPRINUS ALBURNUS L.).

Luxilus Rafinesque, 47; type LUXILUS CHRYSOCEPHALUS Raf. (CYPRINUS CORNUTUS Mitchill).

Chrosomus Rafinesque, 47; type CHROSOMUS ERYTHROGASTER Raf.

Semotilus Rafinesque, 49; type SEMOTILUS DORSALIS Raf. (CYPRINUS ATROMACULATUS Mitchill).

Rutilus Rafinesque, 50; type LEUCISCUS RUTILUS L.

Plargyrus Rafinesque, 50; type RUTILUS PLARGYRUS Raf. (CYPRINUS CORNUTUS Mitchill).

Pimephales Rafinesque, 52; type PIMEPHALES PROMELAS Raf.

Moxostoma Rafinesque, 54; type CATOSTOMUS ANISURUS Raf.

Ictiobus Rafinesque, 55; type CATOSTOMUS BUBALUS Raf.
Spelled ICHTHYOBUS by Agassiz.
The name AMBLODON was based, in part, on the same species, and may be held as tenable for this genus.

Leptops Rafinesque, 64; type PIMELODUS VISCOSUS Raf. (SILURUS OLIVARIS Raf.).

Opladelus Rafinesque, 64; type PIMELODUS NEBULOSUS Raf. (SILURUS OLIVARIS Raf.).
Written HOPLADELUS by Gill. A synonym of LEPTOPS.

Ameiurus Rafinesque, 65; type PIMELODUS CUPREUS Raf. (PIMELODUS NATALIS Le Sueur).

Ilictis Rafinesque, 66; type PIMELODUS LIMOSUS Raf. (SILURUS OLIVARIS Raf.).
A synonym of LEPTOPS.

Picorellus Rafinesque, 70; type ESOX VITTATUS Raf.
A drawing in Rafinesque's note-book shows this to be a mythical species of "pickerel."

Cylindrosteus Rafinesque, 72; type LEPISOSTEUS PLATOSTOMUS Raf.

Atractosteus Rafinesque, 75; type LEPISOSTEUS FEROX Raf.

Sturio Rafinesque, 79; type ACIPENSER MACULOSUS Le Sueur.

Carpiodes Rafinesque, 56; type CATOSTOMUS CYPRINUS Le Sueur.
As fixed by Jordan & Gilbert, 1883.

Teretulus Rafinesque, 57; type CATOSTOMUS AUREOLUS Le Sueur.
As fixed by Jordan, 1877.

Decactylus Rafinesque, 60; type CATOSTOMUS BOSTONIENSIS Le Sueur (CYPRINUS TERES Mitchill) as restricted by Jordan.
CATOSTOMUS TERES is probably the tenable name, as the earlier name COMMERSONI Lacepède is very doubtful.

Ictalurus Rafinesque, 61; type SILURUS PUNCTATUS Raf.

Elliops Rafinesque, 62; type PIMELODUS MACULATUS Raf.
A synonym of ICTALURUS.

Eurystomus Rafinesque, 65; type CATOSTOMUS MEGASTOMUS Raf.
An Audubonian myth.

Sterletus Rafinesque, 80; type ACIPENSER SEROTINUS Raf. (ACIPENSER RUBICUNDUS Le Sueur).

Dinectus Rafinesque, 80; type DINECTUS TRUNCATUS Raf.
Another of Audubon's mythical paintings, representing, as suggested by Rafinesque, "only a sturgeon incorrectly drawn."

Pegedictis Rafinesque, 85; type PEGEDICTIS ICTALOPS Raf.
Apparently a confusion of notes on CATONOTUS FLABELLARIS and COTTUS RICHARDSONI. The species is therefore unidentifiable. Best regarded as a synonym of COTTUS.

Proceros Rafinesque, 87; type PROCEROS MACULATUS Raf.
A myth, not of Audubon but of "Mr. M. of St. Genevieve."

CVI. TILESIUS, *De Piscium Australium Novo Genere*: Mémoires Académie Sciences, Petersburg, 1820.

W. G. VON TILESIUS.

Balistapus Tilesius, 310; type (BALISTES ACULEATUS L.).

CVII. RISSO, *Alepocephalus, nouveau Genre de Poissons:* Mémoires de l'Académie Royale de Turin, XXV, 1820.

ANASTASE RISSO.

Alepocephalus Risso, 262; type ALEPOCEPHALUS ROSTRATUS Risso.

CVIII. GOLDFUSS, *Handbuch Zoologie*, II, 1820.*

GEORG AUGUST GOLDFUSS.

Batrachops Goldfuss; type LOPHIUS COMMERSONIANUS Lacepède.
Substitute for CHIRONECTES, preoccupied. Equivalent to ANTENNARIUS.

CIX. LE SUEUR, *Description of a new Genus and Several New Species of Fresh-Water Fish Indigenous to the United States*: Jour. Ac. Nat. Sci. Phila., II, 1821.

CHARLES A. LE SUEUR.

Mollinesia Le Sueur, 2; type MOLLINESIA LATIPINNA Le Sueur.

CX. HAMILTON, *An Account of the Fishes found in the River Ganges and its Branches*: Edinburgh, 1822.†

FRANCIS HAMILTON [formerly BUCHANAN].
(Often quoted as FRANCIS HAMILTON-BUCHANAN.)

Callichrous Hamilton, 149; type SILURUS BIMACULATUS Bloch.
Synonym of OMPOK Lacepède.

Cynoglossus Hamilton, 365; type CYNOGLOSSUS LINGUA Hamilton.
Monotypic.

Bola Hamilton, 368; type BOLA COITOR Hamilton.
As restricted by Jordan.

Coius Hamilton, 369; type COIUS COBOJUS Hamilton (PERCA SCANDENS DALDORF).
As here restricted by us.

The first species named, COIUS VACTI Hamilton, is LATES COLONORUM. The genus COIUS is grossly unnatural and is best served by relegation to synonymy.

Hamilton observes: "The Cobojus by the natives is considered as the prototype of their genus 'Coi' from which the name COIUS is derived."

Equivalent to ANABAS Cuvier.

Chanda Hamilton, 370; type CHANDA RUCONIUS Hamilton.
The first unquestioned species named. It is a species of LEIOGNATHUS Lacepède. The others named belong to AMBASSIS Cuvier.

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* "ACANTHIOTUS Goldfuss" quoted by Agassiz (Nomenclator) is merely a misprint for ACANTHONOTUS.

† We are indebted to Mr. John Smallwood for the record of the genera of Hamilton.

Sisor Hamilton, 379; type SISOR RABDOPHORUS Hamilton.

Monotypic.

Corica Hamilton, 383; type CORICA COBORNA Hamilton.

Monotypic. Apparently an ally of CLUPEOIDES Bleeker. Not CORICUS Cuvier.

Chela Hamilton, 383; type CYPRINUS CACHIUS Hamilton.

The first species named; as restricted by Bleeker, 1862. Günther later restricts it to C. GORA Hamilton. Replaces CACHIA Günther.

Barilius Hamilton, 384; type by tautonomy CYPRINUS BARILA Hamilton.

The first species named.

Bangana Hamilton, 385; type CYPRINUS DERO Hamilton.

The first species named: probably replaces TYLOGNATHUS Heckel and LOBOCHEILUS van Hasselt.

Puntius Hamilton, 388; type CYPRINUS PUNTIO Hamilton.

By tautonomy. Restricted to CYPRINUS SOPHORE Hamilton by Bleeker.

Danio Hamilton, 390; type CYPRINUS DANGILA Hamilton.

The first species named; as restricted by Bleeker.

Morulius Hamilton, 391; type CYPRINUS MORALA Hamilton.

The first species named; restriction by Bleeker.

Cabdio Hamilton, 392; type CYPRINUS JAYA Hamilton.

The first species named.

Garra Hamilton, 393; type CYPRINUS LAMTA Hamilton.

The first species named; as restricted by Bleeker. Replaces DISCOGNATHUS Heckel.

CXI (A). LEACH & DE LA BÈCHE, *Trans. Zool. Soc. London,* (2) 1822.

WILLIAM E. LEACH.

Dapedium Leach & De La Bèche, 45; type DAPEDIUM POLITUM Leach (fossil).

Written DAPEDIUS by Agassiz.

CXI (B). SCHINZ, *Das Thierreich,* II, 1822.

H. R. SCHINZ.

Macrodon Schinz, 482; type LONCHURUS ANCYLODON Bloch & Schneider.

Replaces ANCYLODON Cuvier, 1817, preoccupied by ANCYLODON Illiger, 1811, a genus of mammals. MACRODON is prior to SAGENICHTHYS Berg, 1895, also a substitute for ANCYLODON. Not MACRODON Müller & Troschel, which is replaced by HOPLIAS Gill, 1903.

CXII. VAN HASSELT, (*Poissons de Java*): **Allgemeine Konst. en Letterbok, II,** 1823.

JAN COENRAD VAN HASSELT.

Homaloptera Van Hasselt, 130; type HOMALOPTERA FASCIATA **Van** Hasselt.

Crossocheilus Van Hasselt, 132; type CROSSOCHEILUS OBLONGUS **Van** Hasselt.

Hampala Van Hasselt, 132; type HAMPALA MACROLEPIDOTA **Van Has**selt.

Lobocheilus Van Hasselt, 133; type LOBOCHEILUS FALCIFER **Van Has**selt.

A synonym of BANGANA.

Nemacheilus Van Hasselt, 133; type COBITIS FASCIATUS **Valenciennes.**

Acanthopsis Van Hasselt, 133; type ACANTHOPSIS DIALYZONA **Van Has**selt.

Acanthophthalmus Van Hasselt, 133; type ACANTHOPHTHALMUS FASCIATUS Van Hasselt.

Homaloptera Van Hasselt, 133; type HOMALOPTERA FASCIATA **Van Has**selt.

Oxygaster Van Hasselt, 133; type OXYGASTER ANOMALURUS **Van Has**selt.

CXIII. DESMAREST, *Première Décade Ichthyologique,* 1823.

ANSELME GAËTAN DESMAREST.

Diabasis Desmarest, 34; type DIABASIS PARRA Desmarest.

Not DIABASIS Hoffmansegg, a genus of beetles, 1819. Replaced by **HÆMULON** Cuvier.

CXIV. NARDO, *Osservazione Aggiunte all' Adriatica Ittiologia,* **1824.**

GIAN DOMENICO NARDO.

Squatinoraja Nardo; type SQUATINORAJA COLONNA (**RHINOBATUS** COLUMNÆ Müller & Henle).

A synonym of RHINOBATUS.

CXV. MITCHILL, *Description of an Extraordinary Fish*: Ann. Lyc. Nat. Hist. N. Y., I, 1824.

SAMUEL LATHAM MITCHILL.

Saccopharynx Mitchill, 82; type SACCOPHARYNX FLAGELLUM Mitchill.

CXVI. VALENCIENNES, *Description du Cernié*: Mém. du Museum, Paris, XI, 1824.

ACHILLE VALENCIENNES.

Polyprion Valenciennes, 265; type POLYPRION CERNIUM Valenciennes.

CXVII. OTTO, *Propterygia hyposticta,* Nova Acta Acad., 1824.

B. C. OTTO.

Propterygia Otto, 111; type PROPTERYGIA HYPOSTICTA Otto.

A deformed RAJA, with the pectoral fins free from the head, similar to CEPHALEUTHERUS Rafinesque.

CXVIII. QUOY & GAIMARD, *Voyage Autour du Monde . . . Exécuté sur les Corvettes l'Uranie et la Physicienne.* Under Captain Louis de Freycinet, 1824.

JEAN RÉNÉ CONSTANTINE QUOY; JOSEPH PAUL GAIMARD.

This important work, which closely preceded the second edition of the *Règne Animal,* adopted a few unpublished names from Cuvier's manuscripts.

Anampses (Cuvier) Quoy & Gaimard, 276; type ANAMPSES CUVIER Q. & G.

Monotypic.

Gerres (Cuvier) Quoy & Gaimard, 293; type GERRES VAIGIENSIS Q. & G., which is SCIÆNA ARGYREA Forskål.

In this paper the genus GERRES is mentioned for the first time. But two species are named, G. VAIGIENSIS and G. GULA. The former belongs to the modern genus XYSTÆMA Jordan & Evermann, the latter to EUCINOSTOMUS Baird. When GERRES was later defined by Cuvier in the *Règne Animal,* SCIÆNA ARGYREA, which is identical with G. VAIGIENSIS, is included, and G. GULA is not mentioned. It would appear that G. VAIGIENSIS must be taken as type, thus replacing XYSTÆMA.

Jordan & Evermann have taken an American species, GERRES LINEATUS (Humboldt) as type. This species is named by Cuvier, but not by Quoy & Gaimard. It cannot therefore serve as the type of GERRES. The genus called GERRES by Jordan & Evermann must apparently stand as DIAPTERUS Ranzani. If GERRES is regarded as preoccupied by GERRIS Fabricius, a genus of insects of earlier date, the substitute name of CATOCHÆNUM Cantor, 1850, should be used.

Percophis Quoy & Gaimard, 351; type PERCOPHIS BRASILIANUS Q. & G.
Monotypic.

Priodon (Cuvier) Quoy & Gaimard, 377; type PRIODON ANNULATUS Q. & G.
A species of NASO Lacepède.

CXVIII (A). HARLAN, *Saurocephalus:* Journ. Ac. Nat. Sci. Phila., III (fossil fish), 1824.

RICHARD HARLAN.

Saurocephalus Harlan, 339; type SAUROCEPHALUS LANCIFORMIS Harlan.

CXIX. KÖNIG, *Icones Fossiles Sectione,* 1825.

C. KÖNIG.

Bucklandium König, 4; type BUCKLANDIUM DILUVII König.
Monotypic.

Ampheristus König, pl. XV, fig. 190; type AMPHERISTUS TOLIACUS König.
Monotypic.

CXX. BOWDICH, *Fishes of Madeira,* 1825.

T. EDWARD BOWDICH.

Labeo Bowdich, 122; type LABEO SPAROIDES Bowdich.
A sparoid fish; not LABEO Cuvier, 1817.

Anomalodon Bowdich, 237; type ANOMALODON INCISUS Bowdich.

Apparently a synonym of POMADASYS Lacepède.

Diastodon Bowdich, 238; type DIASTODON SPECIOSUS Bowdich (LABRUS SCROFA Cuv. & Val.).

This genus appears valid. It is near LEPIDAPLOIS Gill, but with much smaller scales.

Seleima Bowdich, 238; type SELEIMA AURATA Bowdich.

A synonym of KYPHOSUS Lacepède (K. INCISOR).

Amorphocephalus Bowdich, 238; type AMORPHOCEPHALUS GRANULATUS Bowdich.

A synonym of XYRICHTHYS Cuvier.

CXXI. RISSO, *Histoire Naturelle des Principales Productions de l'Europe Méridionale,* vol. III, Paris, 1826.

ANASTASE RISSO.

Lamia Risso, 123; type SQUALUS CORNUBICUS L.

Monotypic. A synonym of LAMNA Cuvier, 1817.

Acanthias Risso, 131; type SQUALUS ACANTHIAS L.

Equivalent to SQUALUS L. as restricted.

Scyphius Risso, 185; type SCYPHIUS FASCIATUS Risso.

A synonym of NEROPHIS Rafinesque, 1810.

Onos Risso, 214; type GADUS MUSTELA Bloch.

A synonym of GAIDROPSARUS Rafinesque.

Lotta Risso, 217; type GADUS ELONGATUS Otto.

A variant of LOTA Cuvier, 1817 ("Les Lottes"); apparently not eligible as a substitute for MOLVA Fleming.

Mora Risso, 224; type MORA MEDITERRANEA Risso.

Morua Risso, 225; type GADUS CAPELAN Lacepède.

According to Risso, a synonym of TRISOPTERUS Rafinesque, 1814; prior to BRACHYGADUS Gill (GADUS MINUTUS L.). Monotypic.

Tripterygion Risso, 241; type TRIPTERYGION NASUS Risso.

Monotypic.

Diana Risso, 267; type DIANA SEMILUNATA Risso.

Monotypic.

Aphia Risso, 287; type APHIA MERIDIONALIS Risso.

Apparently a young ATHERINA. Monotypic.

Fiatola Risso, 289; type FIATOLA FASCIATA Risso.

Monotypic. Apparently a young STROMATEUS.

CXXVII. CLOQUET, *Nouveau Dictionnaire d'Histoire Naturelle:* Nouvelle Edition, XXX, 1827.

HIPPOLYTE CLOQUET.

Sandat Cloquet, XXX, 126, 129; type PERCA LUCIOPERCA L.

Based on "Les Sandres" Cuvier. A synonym of SANDER (Cuvier) Oken.

CXXVIII. RÜPPELL, *Atlas zu der Reise in Nördlichen Afrika:* Fische des Rothen Meeres, 1828.

EDUARD RÜPPELL.

Pharopteryx Rüppell, 15; type PHAROPTERYX NIGRICANS Rüppell.

A synonym of PLESIOPS Cuvier as later shown by Rüppell.

Lutodeira (Van Hasselt) Rüppell, 17; type LUTODEIRA INDICA (MUGIL CHANOS L.).

A synonym of CHANOS. Monotypic.

Scoliostomus Rüppell, 17; same type.

A synonym of CHANOS.

Haliophis Rüppell, 49; type MURÆNA GUTTATA Forskål.

Monotypic.

Pastinachus Rüppell, 82; type RAJA SEPHEN Forskål.

Same as HYPOLOPHUS Müller & Henle. Not PASTINACA Nardo.

Asterropteryx Rüppell, 138; type ASTERROPTERYX SEMIPUNCTATUS Rüppell.

CXXIX. FLEMING, *History of British Animals,* 1828.

JOHN FLEMING.

Selanonius Fleming, 169; type SELANONIUS WALKERI Fleming = SQUALUS NASUS (Bonnaterre).

A synonym of LAMNA Cuvier.

Encrasicholus Fleming, 183; type CLUPEA ENCRASICHOLUS L.

Synonym of ENGRAULIS Cuvier, 1817. Monotypic.

Gobitis Fleming, 189; type COBITIS TÆNIA L.

A perversion of COBITIS.

Morhua Fleming, 190; type GADUS MORRHUA L.

A synonym of GADUS L.

Molva Fleming, 197; type GADUS MOLVA L.

Cernua Fleming, 212; type PERCA CERNUA L.
Same as CERNUA Schæfer or ACERINA Güldenstadt.

Cataphractus Fleming, 216; type COTTUS CATAPHRACTUS L.
A synonym of AGONUS Bloch & Schneider.

Spinachia Fleming, 219; type GASTEROSTEUS SPINACHIA L.

CXXX. STARK, *Elements of Natural History,* Edinburgh, 2 vols., 1828.

JOHN STARK.

Latinization of several of Cuvier's names, some of them differing from the form chosen by Oken. These are the following:

Brosmus Stark, I, 425; type GADUS BROSME Müller.
Same as BROSME Oken, 1817.

Sandrus Stark, I, 452; type PERCA LUCIOPERCA L.
Same as SANDER Oken.

Stelliferus Stark, I, 459; type BODIANUS STELLIFER Bloch.
Same as STELLIFER Oken.

Cingla Stark, I, 465; type PERCA ZINGEL L.
Same as ZINGEL Oken.

Daurada Stark, I, 465; type SPARUS AURATA L.
A synonym of SPARUS L.

CXXXI. LESSON, *Description du Nouveau Genre Ichthyophis:* Mém. Soc. Nat. Hist. Paris, IV, 397, 1828.

R. P. LESSON.

Ichthyophis Lesson, 397; type ICHTHYOPHIS PANTHERINUS Lesson.
Name preoccupied; replaced by UROPTERYGIUS Rüppell.

CXXXII. CUVIER & VALENCIENNES, *Histoire Naturelle des Poissons,* vol. II, 1828.

GEORGES CUVIER and ACHILLE VALENCIENNES.

The first two volumes (the first one being anatomical and descriptive) of this great work preceded the second edition of the *Règne Animal.* The third and fourth volumes, also dated 1829, appeared in the last half of the year. The second edition of the *Règne Animal,* Vol. II, con-

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Same as CERNUA Schæfer or ACERINA Güldenstadt.

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Same as STELLIFER Oken.

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Same as ZINGEL Oken.

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taining the fishes, appeared in the first half of the year 1829, according to Mr. Fowler.

Labrax Cuvier & Valenciennes, II, 55; type PERCA LABRAX L. (LARBAX LUPUS C. & V.).

This is LABRAX of Klein, but not of Pallas, 1811.

Lates Cuvier & Valenciennes, 88; type PERCA NILOTICA L.

Lucioperca Cuvier & Valenciennes, II, 110; type PERCA LUCIOPERCA L. (LUCIOPERCA SANDRA Cuv. & Val.).

A synonym of SANDER Oken.

Huro Cuvier & Valenciennes, 125; type HURO NIGRICANS (LABRUS SALMOIDES Lacepède).

The genus is identical with GRYSTES. Both are synonyms of MICROPTERUS Lacepède.

Etelis Cuvier & Valenciennes, II, 127; type ETELIS CARBUNCULUS Cuv. & Val.

Monotypic.

Diploprion (Kuhl & Van Hasselt) Cuvier & Valenciennes, 137; type DIPLOPRION BIFASCIATUM Kuhl & Van Hasselt.

Monotypic.

Pomatomus (Risso) Cuvier & Valenciennes, II, 171; type POMATOMUS TELESCOPIUM Risso.

Not POMATOMUS Lacepède. Stands as EPIGONUS Rafinesque.

Ambassis (Commerson) Cuvier & Valenciennes, II, 175; type CENTROPOMUS AMBASSIS Lacepède (AMBASSIS COMMERSONI Cuv. & Val.), SCIÆNA SAFGHA Forskål.

Aspro Cuvier & Valenciennes, II, 188; type PERCA ASPER L.

Equivalent to ASPER Schæfer and ASPERULUS Klein. Not ASPRO Commerson. PERCA ASPER is probably generically distinct from ZINGEL (Cuvier) Oken. The genus may stand as ASPER Schæfer or ASPERULUS Klein, both names of questionable eligibility.

Mesoprion Cuvier (*Règne Animal,* 143), Cuv. & Val., II, 441; type LUTIANUS LUTIANUS Bloch.

Name a substitute for LUTJANUS, regarded as barbarous.

CXXXIII. BORY DE SAINT VINCENT, *Dictionnaire Classique d'Histoire Naturelle,* XIII, 201, 1828.

JEAN BAPTISTE GEORGE MARIE BORY DE ST. VINCENT.

Sandat Bory de St. Vincent, XIII, 204, 1828; type PERCA LUCIOPERCA L.

A synonym of SANDER Oken.

CXXXIII (A). SEDGWICK & MURCHISON, *Fossil Fishes:* Trans. Geol. Soc. (2), III, 1828.

ADAM SEDGWICK and RODERIC IMPEY MURCHISON.

Dipterus Sedgwick & Murchison, 143; type DIPTERUS VALENCIENNESI Sedgwick & Murchison.

CXXXIV. CUVIER, *Le Règne Animal, distribué d'Après son Organisation*: Edition II, Vol. II (Fishes etc.), 1829.

GEORGES CUVIER.

A work of great importance, constituting with the first edition in 1817 the foundation of modern Ichthyology. The classification of fishes by Cuvier was for the first time solidly based on the true basis of Comparative Anatomy.

According to Henry Weed Fowler (*Proc. Ac. Nat. Sci. Phila.*, 1907, 264) the first, second, fourth and fifth fascicles of the second volume (*Fishes* etc.) of the Second Edition of the *Règne Animal* appeared in January, February and March 1829. The third was delayed until about July. The third and fourth volumes of the *Histoire Naturelle des Poissons* appeared later in the same year, 1829. These facts do not affect nomenclature, so far as we observe. We are indebted to Mr. Fowler for the pagination of the *Règne Animal*, our two copies being reprints.

Acerina Cuvier, 144 (Cuv. & Val., III, 3); type PERCA CERNUA L.

Identical with CERNUA Schæfer, ACERINA Güldenstadt, PERCIS Klein, and GYMNOCEPHALUS Bloch. The eligibility of these earlier names awaits decision.

Rypticus Cuvier, II, 144 (Cuv. & Val., III, 60); type ANTHIAS SAPONACEUS Bloch.

More correctly written RHYPTICUS.

Pentaceros Cuvier, 145 (Cuv. & Val., III, 30); type PENTACEROS CAPENSIS C. & V.

This name has been regarded as preoccupied by PENTACEROS Schulte, 1760, a star-fish.* It has been replaced by QUINQUARIUS Jordan. This change may not be necessary. According to Prof. Walter K. Fisher PENTACEROS of Schulte is not properly a generic name but a quasi-vernacular.

PENTACEROS Schröter, 1782, a name for the same animal is doubtfully tenable.

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*Dr. Fisher (*Smithson. Misc. Coll.*, no. 1799, 1908) explains that Schulte (*"Versteinerte Seesterne"*) following the pre-Linnæan work of Linck (*De Stel-*

Centropristes Cuvier, 145 (Cuv. & Val., III, 56); type CENTROPRISTES NIGRICANS Cuv. & Val. (LABRUS STRIATUS L.).

Later written CENTROPRISTIS.

Gristes Cuvier (Cuv. & Val., III, 54); type LABRUS SALMOIDES Lacepède.

A synonym of MICROPTERUS Lacepède. Later written GRYSTES.

Chironemus Cuvier (C. & V., 78), 146; type CHIRONEMUS GEORGIANUS Cuv. & Val.

Monotypic.

Pomotis Cuvier, 147 (C. & V., III, 99); type "POMOTIS VULGARIS" (PERCA GIBBOSA L.).

No reference is made to Rafinesque's genus POMOTIS, proposed in 1819, with "LABRUS AURITUS L." as type. The description of Cuv. & Val. refers to the species called PERCA GIBBOSA by Linnæus (EUPOMOTIS GIBBOSUS of Gill & Jordan). To this same species Rafinesque later transferred his generic name POMOTIS. Stands as EUPOMOTIS Gill & Jordan.

Centrarchus Cuvier 147 (C. & V., III, 84); type CYCHLA ÆNEA Le Sueur.

A synonym of AMBLOPLITES Rafinesque, 1820. LABRUS IRIDEUS Lacepède, usually accepted as the type of CENTRARCHUS, is noted by Cuvier as an uncertain species which the author had not seen. The genus typified by IRIDEUS Lacepède (= MACROPTERUS Lacepède) must stand as EUCENTRARCHUS Gill, and its family as MICROPTERIDÆ, as Fowler has already indicated.

Dules Cuvier, 147 (C. & V., III, 111); type DULES AURIGA Cuvier.

Fowler (1907) regards DULES as preoccupied by DULUS Vieillot, 1816, a genus of birds. He gives a new name, EUDULUS, to DULES AURIGA.

Datnia Cuvier, 147 (C. & V., III, 138); type COIUS DATNIA Hamilton (DATNIA ARGENTEA Cuv. & Val.).

Pelates Cuvier, 148 (C. & V., III, 145); type PELATES QUADRILINEATUS Cuv. & Val.

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lis Marinis, 1793) divides the star-fishes into three "genera" ("Geschlechte"), to which he gives group names, the five-rayed forms being under the "genus" "quinquifidæ." Under these are several kinds or species ("Arten"), one of them, "Der fünfhörnichte, PENTACEROS, hat fünf tiefe ausgeschweifte Seiten und lange kolbichte oder zugespitzte Strahlen. Die hierher gehörigen Arten sind entweder platt, PLANÆ, oder ab hockericht und bauchericht, GIBBÆ."

Obviously this is not scientific nomenclature.

"Schröter in 1782 (*Musei Gottwaldiani Testaceorum, Stellarum marinum etc.*, Nürnberg, 58) used PENTACEROS, but he is not a consistent binomialist, and his 'generic' names are not tenable."

It is evident that PENTACEROS has no standing in nomenclature prior to its use by Cuvier & Valenciennes, unless given it by Schröter in 1782, a matter which awaits decision.

Helotes Cuvier, 148 (C. & V., III, 149); type THERAPON SEXLINEATUS Quoy & Gaimard.

Monotypic.

Trichodon (Steller) Cuvier, about 150 (C. & V., III, 153); type TRACHINUS TRICHODON Steller (TRICHODON STELLERI Cuv. & Val.).

Monotypic.

Myripristis Cuvier (about 150), (C. & V., III, 160); type MYRIPRISTIS JACOBUS Cuv. & Val.

Beryx Cuvier (about 150), (C. & V., III, 222); type BERYX DECADACTYLUS Cuv. & Val.

Pinguipes Cuvier, 153 (C. & V., III, 277); type PINGUIPES BRASILIANUS Cuv. & Val.

Monotypic. A synonym of MUGILOIDES Lacepède.

Upeneus Cuvier (about 160), (C. & V., III, 446); type MULLUS BIFASCIATUS Lacepède.

As first restricted by Bleeker. Later Bleeker transferred the name UPENEUS to the first species named by Cuvier & Valenciennes, MULLUS VITTATUS Forskål, already the type of his own genus UPENEOIDES. MULLUS BIFASCIATUS became then PARUPENEUS. This reversal seems to us unjustified. The name has been spelled HYPENEUS. UPENEUS should stand.

Hemitripterus Cuvier, 164; type COTTUS TRIPTERYGIUS Bloch & Schneider.

Hemilepidotus Cuvier, 165; type COTTUS HEMILEPIDOTUS Tilesius.

Monotypic.

Sebastes Cuvier, 166; type PERCA NORVEGICA Müller.

Blepsias Cuvier, 167; type BLENNIUS VILLOSUS Pallas.

Monotypic.

Apistes Cuvier, 167; type APISTES ALATUS Cuvier.

Agriopus Cuvier ("Les Agriopes"), 168; type BLENNIUS TORVUS Walbaum.

Pelor Cuvier, 168; type SCORPÆNA DIDACTYLA Pallas (PELOR OBSCURUM Cuvier).

Monotypic. Name preoccupied for a genus of beetles, 1813. Replaced by INIMICUS Jordan & Starks (type PELOR JAPONICUM Cuv. & Val.). P. FILAMENTOSUM Cuv. & Val. cannot be taken as the type of PELOR, as Cuvier names but one species, the others being then undescribed. This species, with two of the pectoral rays tipped with filaments, may belong to a different genus.

Oreosoma Cuvier (about 170); type (not named) OREOSOMA ATLANTICUM Cuvier.

Corvina Cuvier, 173; type SCIÆNA NIGRA Gmelin; part of SCIÆNA UMBRA L.

The species SCIÆNA UMBRA L., the type of the genus SCIÆNA, was two-fold, a complex about evenly divided of the species called SCIÆNA NIGRA Gmelin and CHEILODIPTERUS AQUILA Lacepède. The synonymy was disentangled by Cuvier (*Mem. du Museum*, 1815) and the name SCIÆNA UMBRA retained in place of S. AQUILA. In accepting this decision we restore the generic name CORVINA, for the "Corb," which becomes CORVINA NIGRA, while SCIÆNA replaces ARGYROSOMUS de la Pylaie and PSEUDOSCIÆNA Bleeker for the "Maigre," which remains SCIÆNA UMBRA L., the type of SCIÆNA L.

Hæmulon Cuvier, 175; type HÆMULON ELEGANS Cuvier (SPARUS SCIURUS Shaw).

Lobotes Cuvier, 177; type HOLOCENTRUS SURINAMENSIS Bloch.

Monotypic.

Scolopsides Cuvier, 178; type SCOLOPSIDES KURITA Cuvier.

Called SCOLOPSIS in Edition I.

Dascyllus Cuvier, 179; type CHÆTODON ARUANUS L.

Monotypic.

Heliases Cuvier; type (not indicated) HELIASTES INSOLATUS Cuv. & Val.

Identical with CHROMIS Cuvier, 1815, not CROMIS Browne, 1789, nor CHROMIS Plumier.

Chrysophris Cuvier, 181; type SPARUS AURATA L.

A synonym of SPARUS L.

Pagellus Cuvier (about 182); type SPARUS ERYTHRINUS L.

Pentapus Cuvier ("Les Pentapodes") (about 182); type SPARUS VITTATUS Bloch.

Lethrinus Cuvier (about 182); type SPARUS CHŒROHYNCHUS Bloch & Schneider.

Oblada Cuvier, 185; type SPARUS MELANURUS L.

Monotypic.

Mæna Cuvier; type SPARUS MÆNA L.

Taurichthys Cuvier, 192; type TAURICHTHYS VARIUS Cuvier.

A subgenus of HENIOCHUS Cuvier.

Psettus (Commerson) Cuvier (about 193); type CHÆTODON RHOMBEUS Bloch & Schneider.

Synonym of MONODACTYLUS Lacepède.

Dipterodon Cuvier (about 195); type DIPTERODON CAPENSIS Cuvier.

Not DIPTERODON Lacepède, 1803. Monotypic. Replaced by DICHISTIUS Gill.

Pempheris Cuvier, 195; type KURTUS ARGENTEUS Bloch & Schneider (PEMPHERIS TOUEA Cuvier).

Auxis Cuvier, 199; type SCOMBER ROCHEI Risso (SCOMBER THAZARD Lacepède).

Sarda Cuvier, 199; type SCOMBER SARDA Bloch.

Later (1831) called PELAMYS by Cuvier & Valenciennes. Monotypic. Not SARDA Plumier.

Cybium Cuvier, 199; type SCOMBER COMMERSONI Lacepède.

A synonym of SCOMBEROMORUS Lacepède, 1803.

Thyrsites Cuvier (about 200); type SCOMBER ATUN Euphrasen.

Gempylus Cuvier, 200; type GEMPYLUS SERPENS Cuvier.

This is identical with LEMNISOMA of Lesson, but the date of LEMNISOMA is 1830.

Elacate Cuvier, II, 203, as "LES ELACATES," the Latin name dating from C. & V., 1831; type ELACATE MOTTA C. & V.

Synonym of RACHYCENTRON Kaup.

Olistus Cuvier, II, 209; type (not named) OLISTUS MALABARICUS Cuv. & Val.

Scyris Cuvier, II, 209; type "LE GAL D'ALEXANDRIE," SCYRIS INDICA Cuv. & Val.

Not separable from ALECTIS Raf.

Blepharis Cuvier (about 210); type ZEUS CILIARIS Bloch.

Name preoccupied, replaced by BLEPHARICHTHYS Gill. A synonym of ALECTIS.

Peprilus Cuvier, 213; type PEPRILUS CRENULATUS.

Probably the young of PEPRILUS ALEPIDOTUS Cuvier. Monotypic. Same as RHOMBUS Lacepède, not of Klein.

Astrodermus (Bonelli) Cuvier (about 215); type ASTRODERMUS GUTTATUS Bonelli Ms. (DIANA SEMILUNATA Risso).

Axinurus Cuvier, 225; type AXINURUS THYNNOIDES Cuvier.

Monotypic.

Priodon Cuvier, 225; type PRIODON ANNULARIS Cuvier.

Polyacanthus (Kuhl) Cuvier, 227; type TRICHOPODUS COLISA Hamilton.

Helostoma (Kuhl) Cuvier, 228; type HELOSTOMA TEMMINCKI Cuvier.

Monotypic.

Spirobranchus Cuvier, 229; type SPIROBRANCHUS CAPENSIS Cuvier.

Monotypic.

Myxodes Cuvier, 238; type (not named) MYXODES VIRIDIS Cuv. & Val.

Cirrhibarbus Cuvier ("LES CIRRHIBARBES") 238; type (not named) CIRRHIBARBIS CAPENSIS Cuv. & Val.

Monotypic.

Zoarces Cuvier (about 240); type BLENNIUS VIVIPARUS L.

Equivalent to ENCHELYOPUS Gronow, 1763.

Platyptera (Kuhl & van Hasselt) Cuvier, 248; type PLATYPTERA MELANOCEPHALA K. & v. H.

Name preoccupied, replaced by RHYACICHTHYS Boulenger.

Chirus (Steller) Cuvier, about 250; type LABRAX LAGOCEPHALUS Pallas.

Substitute for LABRAX Klein.

Antennarius (Commerson) Cuvier (about 251); type LOPHIUS COMMERSONIANUS Lacepède.

Accepted as a substitute for CHIRONECTES Cuvier, 1817, preoccupied.

Malthe Cuvier, 252; type LOPHIUS VESPERTILIO L.

Synonym of OGCOCEPHALUS Fischer. Monotypic.

Lachnolaimus Cuvier, 257; type LACHNOLAIMUS SUILLUS Cuvier.

SUILLUS of Catesby. Monotypic.

Anampses Cuvier, 259; type ANAMPSES CUVIERI Quoy & Gaimard.

Clepticus Cuvier, 261; type CLEPTICUS GENIZARA Cuvier.

Monotypic.

Malacanthus Cuvier, 264; type CORYPHÆNA PLUMIERI Bloch.

Calliodon Cuvier ("LES CALLIODON"), (about 265); type SCARUS SPINIDENS Q. & G.

Not identical with CALLYODON Gronow nor of Bloch & Schneider. Replaced by CRYPTOTOMUS Cope, 1871.

Odax Cuvier (about 265); type SCARUS PULLUS Forster.

Monotypic. Not ODAX Commerson.

Mallotus Cuvier, II, 305; type SALMO GRŒNLANDICUS Bloch (CLUPEA VILLOSA Gmelin).

Thymallus Cuvier, 306; type SALMO THYMALLUS L.

Regarded by some as preoccupied by THYMALUS Latreille, 1802, a genus of beetles; replaced by CHOREGON Minding, 1832. But the scantily noted THYMALLUS of Linck, 1791, has priority over THYMALUS, if acceptable. The root-words of THYMALLUS and THYMALUS are not identical, THYMALLUS being a Latin name of the Grayling.

Coregonus Cuvier; type SALMO OXYRHYNCHUS L.

Alosa Cuvier, 319; type CLUPEA ALOSA L.

Same as ALOSA Linck.

Chatoëssus Cuvier, 320; type MEGALOPS CEPEDIANUS Le Sueur.

As restricted by Cuv. & Val. Equivalent to DOROSOMA Rafinesque.

Thryssa Cuvier; type CLUPEA SETIROSTRIS Broussonet (THRISSA Cuv. & Val., 1817).

Not THRISSA Rafinesque, 1815. To be replaced by THRISSOCLES Jordan, a new generic name.

Motella Cuvier, 334; type GADUS MUSTELA L.

Substitute for MUSTELA Cuvier, 1817, preoccupied in mammals. Identical with GAIDROPSARUS Rafinesque, 1810.

Monochir Cuvier, 336; type PLEURONECTES MICROCHIRUS De la Roche.

Substitute for MONOCHIRUS, preoccupied. Not sufficiently different.

Osteoglossum (Vandelli) Cuvier (about 390); type OSTEOGLOSSUM VANDELLI Cuvier.

Gymnarchus Cuvier (about 390); type GYMNARCHUS NILOTICUS Cuvier.

Triodon Cuvier (about 390); type TRIODON BURSARIUS Reinwardt.

Anacanthus (Ehrenberg) Cuvier (about 390); type (not named) RAJA UARNAK Forskål.

Monotypic. Replaces HIMANTURA Müller, 1837.

Heterotis Ehrenberg; type SUDIS NILOTICUS Cuv. & Val.

Quoted from the *Règne Animal* by Günther, but we do not find it there. Apparently it appears first in Cuv. & Val., XIX, 465, 1846.

CXXXV. AGASSIZ (AND SPIX), *Selecta Genera et Species Piscium quos in Itinere per Brasiliam, 1817, 1820, Collejit Dr. J. B. de Spix, 1829.*

LOUIS AGASSIZ and JEAN BAPTISTE SPIX.

The date of this work is apparently a little later than that of the Second Edition of the *Règne Animal.*

Acanthicus Spix, 2; type ACANTHICUS HYSTRIX Spix.

Rhinelepis Spix, 2; type RHINELEPIS ASPERA Spix.

Cetopsis Agassiz, 8; type CETOPSIS CÆCUTIENS Agassiz.

Hypophthalmus Spix, 9; type HYPOPHTHALMUS EDENTULUS Spix.

Phractocephalus Agassiz, 10; type PHRACTOCEPHALUS BICOLOR Agassiz.

Platystoma Agassiz, 10; type SILURUS LIMA Bloch & Schneider.

Name preoccupied by a genus of flies, Meigen, 1803.

Glanis Agassiz, 10; type not named.

Name given in dative case only "*In Glanide Agass.*" Substitute for BAGRE Cuvier, rejected because of barbarous origin. Afterwards (1856) GLANIS was revived as the generic name for the Greek cat-fish, GLANIS ARISTOTELIS Agassiz, which is perhaps a PARASILURUS.

Ceratorhynchus Agassiz, 10; type SILURUS MILITARIS Bloch & Schneider.

Not L. Name given in genitive only as "CERATORHYNCHI." Genus close to AGENEIOSUS Lacepède but with the two short barbels replaced by erectile bony weapons.

Centrochir Agassiz, 14; type DORAS CROCODILI Humboldt. Based on a species of DORAS "non modo pinna pectorali uniradiata sed etiam appendice quadriradiata primæ caudalis maxime."

Sorubim Spix, 24; type SILURUS LIMA Bloch & Schneider.

Replaces PLATYSTOMA.

Xiphorhynchus Agassiz, 18; type SALMO FALCATUS Bloch.

Salminus Agassiz, 18; type HYDROCYON BREVIDENS Cuvier.

Osteoglossum (Vandelli) Agassiz, 46; type OSTEOGLOSSUM VANDELLI Cuv. & Val.

Ischnosoma Spix, 47; type ISCHNOSOMA BICIRRHOSUM Spix.

A deformed OSTEOGLOSSUM.

Glossodus (Cuvier) Agassiz, 48; type GLOSSODUS FORSKALI Agassiz (ESOX VULPES L.).

Same as ALBULA Gronow.

Anodus Spix, 57; type ANODUS ELONGATUS Spix.

Prochilodus Agassiz, 57; type PROCHILODUS ARGENTEUS Spix.

Leporinus Spix, 58; type LEPORINUS NOVEMFASCIATUS Spix.

Schizodon Agassiz, 58; type SCHIZODON FASCIATUS Agassiz.

Same as ANOSTOMUS Gronow.

Rhaphiodon Agassiz, 59; type RHAPHIODON VULPINUS Agassiz.

Cynodon Spix, 59, 76; type CYNODON GIBBUS Spix.

As restricted by Eigenmann. Not CYNODONTA Schuhmacher, 1817, a genus of mollusks.

Name changed to RHAPHIODON because earlier used in botany.

Xiphostoma Spix, 60, 78; type XIPHOSTOMA CUVIERI Spix.

Micropteryx Agassiz, 102; type (not named) SERIOLA DUMERILI Cuvier.

Substitute for SERIOLA, preoccupied in botany. A synonym of SERIOLA Cuvier.

Corniger Agassiz, 119; type CORNIGER SPINOSUS Agassiz.

Pachyurus Agassiz, 125; type PACHYURUS SQUAMIPINNIS Agassiz.

CXXXVI. CUVIER & VALENCIENNES, *Histoire Naturelle des Poissons,* IV, 1829.

GEORGES CUVIER and ACHILLE VALENCIENNES.

Hoplichthys Cuv. & Val., IV, XIX, 1829; type HOPLICHTHYS LANGSDORFII Cuv. & Val.

Called HOPLICHTHYS in table of contents, OPLICHTHYS in the text.

Oplichthys Cuv. & Val., IV, 264, 1829; type OPLICHTHYS LANGSDORFII Cuv. & Val.

A variant in spelling.

Bembras Cuv. & Val., IV, 282; type BEMBRAS JAPONICUS Cuv. & Val.

Minous Cuv. & Val., IV, 420, 1829; type MINOUS WOORA Cuv. & Val.

Name changed to CORYTHOBATUS by Cantor, 1850, on account of MINOIS Hübner, 1816, a genus of butterflies.

Hoplostethus Cuv. & Val., IV, 469; type HOPLOSTETHUS MEDITERRANEUS Cuv. & Val.

CXXXVII. COCCO, *Su Alcuni Nuovi Pesce del Mar di Messina*: Archivio della R. Academia Peloritano, 1829.

ANASTASIO COCCO.

Argyropelecus Cocco, 146; type ARGYROPELECUS HEMIGYMNUS Cocco.

CXXXVIII. COCCO, *Su Alcuni Nuovi Pesci del Mar di Messina*: Giorni Sci. Lett. Sicilia, XXVI, no. 77, 1829.

Nyctophus Cocco, 44; type NYCTOPHUS RAFINESQUEI Cocco.

Substitute for MYCTOPHUM.

CXXXIX. COCCO, *Sullo Schedophilus Medusophagus:* Giorn, Cabin de Messina, I, 30 to 32; also quoted as Innom. Messina Ann., III, 1829, p. 57.

Schedophilus Cocco, 30, 57; type SCHEDOPHILUS MEDUSOPHAGUS Cocco.

We have seen none of these papers of Cocco.

CXL. SERVILLE, *Faune Française,* 1820 to 1830.

"Livraison 24 par M. Serville" contains the fishes. This bears no date, but it was probably issued about 1829. It is not quoted by Cuvier, nor does it quote Cuvier. The date is not important, as no question of priority is concerned. This work is commonly ascribed to Blainville, who with Vieillot, Desmarest, Serville and others edited the series. In any event, the work is based on Blainville's *Prodrome*. All of Blainville's generic names ending in BATUS are here changed to BATIS.

AUDINET-SERVILLE.

Dasybatis Serville, 12, 1829 ("RAIES EPINEUSES"); type RAJA BATIS L.
Same as RAJA.

Narcobatis (Blainville) Serville, 45 ("RAIES TORPILLES"); type RAIA TORPEDO L.
Same as NARCACION Klein, TORPEDO Duméril, not of Forskål. Called NARCOBATUS by Blainville, 1816.

Pristibatis Serville, 49 ("RAIES SCIES"); type SQUALUS PRISTIS L. (PRISTIBATIS ANTIQUORUM Blainville).

CXLI. VALENCIENNES, *Poissons Fossiles:* Trans. Geol. Soc., III, 1829.

ACHILLE VALENCIENNES.

Osteolepis Valenciennes, 144; type OSTEOLEPIS MACROLEPIDOTUS Valenciennes.

CXLII. CUVIER & VALENCIENNES, *Histoire Naturelle des Poissons,* Vols. V (January) and VI (July) 1830.

GEORGES CUVIER and ACHILLE VALENCIENNES.

Larimus Cuvier & Valenciennes, V, 146; type LARIMUS BREVICEPS Cuv. & Val.
Monotypic.

Nebris Cuvier & Valenciennes, V, 149; type NEBRIS MICROPS Cuv. & Val.
Not NEBRIA Latreille, 1802, a genus of beetles. Monotypic.

Lepipterus Cuvier & Valenciennes, V, 151; type LEPIPTERUS FRANCISCI Cuv. & Val.

Monotypic.

Boridia Cuvier & Valenciennes, V, 154; type BORIDIA GROSSIDENS Cuv. & Val.

Monotypic.

Conodon Cuvier & Valenciennes, V, 156; type CONODON ANTILLANUS Cuv. & Val. (PERCA NOBILIS L.).

Monotypic. Same as CHELONIGER Plumier.

Eleginus Cuvier & Valenciennes, 158; type ELEGINUS MACLOVINUS Cuv. & Val.

Monotypic. Not ELEGINUS Fischer, 1813. Replaced by ELEGINOPS Gill.

Micropogon Cuvier & Valenciennes, V, 213; type MICROPOGON LINEATUS Cuv. & Val. (PERCA UNDULATA L.).

The original types of LINEATUS were from New York.

Latilus Cuvier & Valenciennes, V, 368; type LATILUS ARGENTATUS Cuv. & Val. (CORYPHÆNA JAPONICA Houttuyn).

A synonym of BRANCHIOSTEGUS Rafinesque, 1815.

Macquaria Cuvier & Valenciennes, V, 377; type MACQUARIA AUSTRALASICA Cuv. & Val.

Monotypic.

Etroplus Cuvier & Valenciennes, V, 486; type ETROPLUS MELEAGRIS Cuv. & Val. (CHÆTODON SURATENSIS Bloch).

As restricted by Bleeker.

Box Cuvier & Valenciennes, VI, 346; type SPARUS BOOPS L. (BOX VULGARIS Cuv. & Val.).

A synonym of BOOPS Cuvier.

Scatharus Cuvier & Valenciennes, VI, 375; type SCATHARUS GRÆCUS Cuv. & Val.

Monotypic.

Crenidens Cuvier & Valenciennes, VI, 377; type CRENIDENS FORSKALII Cuv. & Val.

Monotypic.

Aphareus Cuvier & Valenciennes, VI, 485; type LABRUS FURCATUS Lacepède.

Monotypic.

Aprion Cuvier & Valenciennes, VI, 544; type APRION VIRESCENS Cuv. & Val.

Monotypic.

Apsilus Cuvier & Valenciennes, VI, 548; type APSILUS FUSCUS Cuv. & Val.

Monotypic.

CXLIII. BENNETT, *Catalogue of the Fishes of Sumatra*: in Life and Public Services of Sir Stamford Raffles, 1830.

EDWARD TURNER BENNETT.

Monotaxis Bennett, 688; type MONOTAXIS INDICA Bennett (SCIÆNA GRANDOCULIS Forskål).
Replaces SPHÆRODON Rüppell.

CXLIV. BRONN, *Ueber Zwei Fossile Fischarten*: Neues Jahrbuch Mineralogie, 1830.

HEINRICH GEORG BRONN.

Tetragonolepis Bronn, 30; type TETRAGONOLEPIS SEMICINCTUS Bronn.
Monotypic.

CXLV. HAYS, *Saurodon*: Trans. Amer. Philos. Soc., III, 1830.

I. HAYS.

Saurodon Hays, 475; type SAURODON LEANUS Hays (fossil).

CXLVI. CUVIER & VALENCIENNES, *Histoire Naturelle des Poissons*, VII (January) and VIII (October), 1831.

GEORGES CUVIER and ACHILLE VALENCIENNES.

Chelmon Cuvier & Valenciennes, VII, 86; type CHÆTODON ROSTRATUS L.

Zanclus (Commerson) Cuv. & Val., VII, 92, 1831; type CHÆTODON CORNUTUS L.

Drepane Cuvier & Valenciennes, VII, 132; type CHÆTODON PUNCTATUS L.

Scatophagus Cuvier & Valenciennes, VII, 136; type CHÆTODON ARGUS L.

Psettus (Commerson) Cuvier & Valenciennes, VII, 240; type PSETTUS COMMERSONI Cuv. & Val. (MONODACTYLUS FALCIFORMIS Lacepède).

Pempheris Cuvier & Valenciennes, VII, 296; type PEMPHERIS OUALENSIS Cuv. & Val.

Toxotes Cuvier & Valenciennes, VII, 310; type SCLÆNA JACULATRIX Pallas.

Monotypic.

Colisa Cuvier & Valenciennes, VII, 359; type COLISA VULGARIS Cuv. & Val. (TRICHOPODUS COLISA Hamilton).

Same as TRICHOGASTER Bloch & Schneider as restricted by Cuv. & Val.

Spirobranchus Cuvier & Valenciennes, VII, 392; type SPIROBRANCHUS CAPENSIS Cuv. & Val.

Monotypic.

Bryttus Cuvier & Valenciennes, VII, 454, 461; type BRYTTUS PUNCTATUS Cuv. & Val.

Same as APOMOTIS Rafinesque.

Nandus Cuvier & Valenciennes, VII, 481; type NANDUS MARMORATUS Cuv. & Val. (COIUS NANDUS Hamilton).

Rhynchichthys Cuvier & Valenciennes, VII, 504; type RHYNCHICHTHYS PELAMIDIS Cuv. & Val.

The young of HOLOCENTRUS.

Lichia Cuvier & Valenciennes, VIII, 340, 1831; type SCOMBER AMIA L.

Chorinemus Cuvier & Valenciennes, VIII, 367; type SCOMBEROIDES COMMERSONIANUS Lacepède.

A synonym of SCOMBEROIDES Lacepède.

Aplodactylus Cuvier & Valenciennes, VIII, 476; type APLODACTYLUS PUNCTATUS Cuv. & Val.

Usually written HAPLODACTYLUS.

Aphritis Cuvier & Valenciennes, VIII, 483; type APHRITIS URVILLI Cuv & Val.

Monotypic.

Bovichtus Cuvier & Valenciennes, VIII, 487; type CALLIONYMUS DIACANTHUS Carmichæl.

CXLVII. JARDINE, *Acestra*, 1831.

SIR WILLIAM JARDINE.

Acestra Jardine; type SYNGNATHUS ÆQUOREUS Rafinesque.

A synonym of NEROPHIS Rafinesque. We take this incomplete reference from Bonaparte, *Catalogo Metodico*, 1846, 91.

CXLVIII. GRAY, *Description of Twelve New Genera of Fish found by General Hardwicke in India*: Zool. Misc., 1831, 7-10.

JOHN EDWARD GRAY.

Centracion Gray, 5; type CENTRACION ZEBRA Gray.
Equivalent to HETERODONTUS Blainville, regarded as preoccupied by HETERODON Latreille, a genus of serpents.

Temera Gray, 7, 152; type TEMERA HARDWICKEI Gray.
Monotypic. Also in Ill. Ind. Zool.

Botia Gray, 8; type BOTIA ALMORHÆ Gray.

Nandina Gray, 8; type CYPRINUS NANDINA Hamilton.

Chaca Gray, 8; type PLATYSTACUS CHACA Hamilton.

Coilia Gray, 9; type COILIA HAMILTONI Gray.

Raconda Gray, 9; type RACONDA RUSSELLIANA Gray.

Moringua Gray, 9; type MORINGUA LATERALIS Gray.
Also in Ill. Ind. Zool., 95.

CXLIX. GRAY, *Illustrations of Indian Zoology, chiefly selected from the collection of General Hardwicke.*

Two volumes of excellent plates, but without text; the plates not paged, but with manuscript numbers. Vol. I, 1830-1832, Vol. II, 1833-1834. The exact dates are uncertain. The first five of the following occur in CXLVIII; also, pp. 8, 9.

Ailia Gray, 85, 1831; type AILIA BENGALENSIS Gray.

Acanthonotus Gray, 85, 1831; type ACANTHONOTUS CUVIERI Gray (AILIA BENGALENSIS Gray).
Name preoccupied. Same as AILIA. Based on injured specimen.

Anacanthus Gray, 85, 1831; type ANACANTHUS BARBATUS Gray.
Name preoccupied by ANACANTHUS Ehrenberg, 1829. Replaced by PSILOCEPHALUS Swainson.

Diplopterus Gray, 87, 1831; type DIPLOPTERUS PULCHER Gray.
Not identified; said to have two anal fins. Name preoccupied in birds, Boie.

Rataboura Gray, 95, 1831; type MURÆNA RATABOURA Hamilton (RATABOURA HARDWICKEI Gray).
Same as MORINGUA Gray, but with line priority.

Bedula Gray, 88, 1833; type BEDULA NEBULOSA Gray.
A synonym of NANDUS Cuv. & Val., 1831.

Pterapon Gray, II, 88, 1833; type PTERAPON TRIVITTATUS Gray (SCIÆNA JARBUA Forskål).
A synonym of THERAPON Cuvier.

Amora Gray, II, 90, 1833, corrected in manuscript to ANAORA; type AMORA TENTACULATA Gray.
Not identified. A platycephalus-like fish with tentacles over eye and spinules on sides. Perhaps a species of THYSANOPHRYS Ogilby.

Apterygia Gray, II, 92, 1833; type APTERYGIA RAMCARATE Gray.
Same as RACONDA Gray.

Tor Gray, II, 96, 1833; type CYPRINUS TOR Hamilton (TOR HAMILTONI Gray).
Replaces LABEOBARBUS Bleeker.

Bengala Gray, 96, 1833; type CYPRINUS ELANGA Hamilton.
Replaces MEGARASBORA Günther, 1868.

Amanses Gray, II, 98, 1833; type AMANSES HYSTRIX Gray (MONACANTHUS SCOPAS Cuvier).

Acarana Gray, II, 98, 1833; type OSTRACION AURITUS Shaw.
Also in Annals Nat. Hist., I, 110, 1838.

Girella Gray, II, 98, 1833; type GIRELLA PUNCTATA Gray.

CL. GRAY, *Description of three new species of fish including two undescribed genera discovered by John Reeves in China:* Zoological Miscellany, 1831.

Leucosoma Gray, 4; type LEUCOSOMA REEVESI Gray (ALBULA CHINENSIS Osbeck).
Monotypic. A synonym of SALANX Cuvier and of ALBULA Osbeck.

Samaris Gray, 4; type SAMARIS CRISTATUS Gray.
Monotypic.

CLI. GRAY, *Description of a new genus of Percoid fish, discovered by Samuel Stutchbury in the Pacific Seas*: Zoological Miscellany, 1831.

Micropus Gray, 20; type MICROPUS MACULATUS Gray.
Name preoccupied by MICROPUS Wolf, 1810, a genus of birds. Replaced by CARACANTHUS Kröyer, 1844 (C. TYPICUS).

CLI (A). LESSON, *Voyage Autour du Monde sur la corvette La Coquille, under Captain L. I. Duperrey*, 1830.

R. P. LESSON.

Lemnisoma Lesson, 160; type LEMNISOMA THYRSITOIDES Lesson.
A synonym of GEMPYLUS Cuvier.

CLII. MINDING, *Lehrbuch, Naturgeschichte der Fische*, 1832.

JULIUS MINDING.

Not seen by us.

Pompilus Minding, 108; type GASTEROSTEUS DUCTOR L.
Same as NAUCRATES.

Choregon Minding, 119; type SALMO THYMALLUS L.
Substitute for THYMALLUS Cuvier, regarded as preoccupied by THYMALUS Latreille, 1802, a genus of beetles. But the two names seen to be from different roots. THYMALLUS Linck, with a word or two of definition, is older than THYMALUS Latreille.

CLIII. NILSSON, *Prodromus Ichthyologiæ Scandinavicæ*, 1832.

S. NILSSON.

Salvelini Nilsson, 7; type SALMO SALVELINUS L. (SALMO ALPINUS L.).
As group name. The normal form SALVELINUS used by Richardson, *Fauna Boreali Americana*, III, 169, 1836.

CLIV. AGASSIZ, *Fossile Fischreste:* Neues Jahrbuch Mineralogie, 1832.

LOUIS (JEAN RODOLPHE) AGASSIZ.

Ptycholepis Agassiz, 142; type PTYCHOLEPIS BOLLENSIS Agassiz.

Uræus Agassiz, 142; type URÆUS FURCATUS Agassiz.
Name preoccupied by Wagler, 1830. Replaced by CATURUS Agassiz, 1834.

Sauropsis Agassiz, 142; type SAUROPSIS LATUS Agassiz.

Pholidophorus Agassiz, 145; type PHOLIDOPHORUS MACROCEPHALUS Agassiz.

Semionotus Agassiz, 144; type SEMIONOTUS BERGERI Agassiz.

Lepidotes Agassiz, 145; type LEPIDOTES GIGAS Agassiz (CYPRINUS ELVENSIS Blainville).

Later written LEPIDOTUS.

Leptolepis Agassiz, 146; type LEPTOLEPIS BRONNI Agassiz.

Acanthoëssus Agassiz, 149; type ACANTHOESSUS BRONNI Agassiz.

Later called ACANTHODES.

CLV. VON MEYER, *Palæologica*, 1832.

H. VON MEYER.

Lepidosaurus von Meyer, 208; type LEPIDOTUS UNGUICULATUS Agassiz.

A synonym of LEPIDOTES.

CLVI. BONAPARTE, *Iconografia della Fauna Italica*: III, 1832-1841.

CARLO LUCIANO PRINCIPE BONAPARTE
(otherwise CHARLES LUCIEN BONAPARTE, Prince of Canino).

An elaborate and finely illustrated work, issued in fascicles, these being numbered but not paged. The number of the fascicle is noted below, with the approximate date of each.

Cerna Bonaparte, 18, 1832; type PERCA GIGAS Brünnich (LABRUS GUAZA L.).

A synonym of EPINEPHELUS Bloch as now restricted.

Microchirus Bonaparte, 28, 1832; type PLEURONECTES MICROCHIRUS De la Roche.

MONOCHIRUS Cuvier, not of Rafinesque.

Monochirus Bonaparte,* 28, 1832; type SOLEA MONOCHIR Bonaparte.

Same as MONOCHIRUS Rafinesque.

Squalius Bonaparte, 96, 1834; type LEUCISCUS SQUALUS Bonaparte (CYPRINUS CEPHALUS L.).

Same as LEUCISCUS.

Telestes Bonaparte, 103, 1834; type TELESTES MUTICELLUS Bonaparte.

Ichthyococcus Bonaparte, 138, 1834; type ICHTHYOCOCCUS OVATUS Bonaparte.

Name later altered to COCCIA by Günther because of its objectionable form.

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* For sake of completeness we add the remaining new genera of the later fascicles of the *Fauna Italica*.

CLI (A). LESSON, *Voyage Autour du Monde sur la corvette La Coquille, under Captain L. I. Duperrey*, 1830.

R. P. LESSON.

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Same as NAUCRATES.

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Pholidophorus Agassiz, 145; type PHOLIDOPHORUS MACROCEPHALUS Agassiz.

Semionotus Agassiz, 144; type SEMIONOTUS BERGERI Agassiz.

Lampugus Cuvier & Valenciennes, IX, 317; type SCOMBER PELAGICUS L.
Same as CORYPHÆNA L.

Aphredoderus (Le Sueur) Cuv. & Val., IX, 445; type APHREDODERUS GIBBOSUS Le Sueur (SCOLOPSIS SAYANUS Gilliams).
Monotypic.

CLVIII. LOWE, *Description of a New Genus of Acanthopterygian Fishes*: Proc. Zool. Soc. London, 1833.

RICHARD THOMAS LOWE.

Alepisaurus Lowe, 104; type ALEPISAURUS FEROX Lowe.
Monotypic. Equivalent to PLAGYODUS Steller, 1811.

CLIX. LOWE, *Characters of a New Genus and of Several New Species of Fishes from Madeira:* Proc. Zool. Soc. London, I, 1833. (Also repeated in other papers.)

Leirus Lowe, 142; type LEIRUS BENNETTI Lowe = CENTROPHORUS OVALIS Cuv. & Val., 1833 = MUPUS IMPERIALIS Cocco, 1833.
Same as MUPUS Cocco of the same date. LEIRUS may be given precedence.

CLX. COCCO, *Lettere al Signor Risso su alcuni Pesci Novelli*: Giorn. Sci. Lett. Sicilia, XLII, no. 124, 1833.

ANASTASIO COCCO.

Tylosurus Cocco; type TYLOSURUS CANTRAINI Cocco (ESOX IMPERIALIS Rafinesque).

CLXI. COCCO, *Su Alcuni Pesci dei Mare di Messina:* Giorn. Sci. Lett. Sicilia, XLII, 1833.

Mupus Cocco, 20; type MUPUS IMPERIALIS Cocco (CENTROLOPHUS OVALIS Cuv. & Val.).
Same as LEIRUS Lowe of the same date.

Lampanyctus Bonaparte, 139, 1834; type LAMPANYCTUS BONAPARTEI Bonaparte.

Chlorophthalmus Bonaparte, 144, 1834; type CHLOROPHTHALMUS AGASSIZI Bonaparte.

Scardinius Bonaparte, 146, 1834; type LEUCISCUS SCARDAFA Bonaparte.

Membras Bonaparte, 1836; type (an "exotic species" not named except by reference to Valenciennes); ATHERINA MARTINICA Cuv. & Val.

Replaces KIRTLANDIA Jordan & Evermann.

Menidia Bonaparte, 1836; type (an "exotic species" not directly named). ATHERINA MENIDIA L.

Hepsetia Bonaparte, 1836; type ATHERINA BOYERI L.

Not separable from ATHERINA L.

Ichthyocoris Bonaparte, 1836; type BLENNIUS VARUS Risso.

A synonym of BLENNIUS L.

CLVI (A). RAFINESQUE, *Atlantic Journal and Friend of Knowledge*, I, 1832.

CONSTANTINE SAMUEL RAFINESQUE.

Trinectes Rafinesque; type TRINECTES SCABRA Rafinesque (PLEURONECTES MOLLIS Mitchill).

A subgenus under ACHIRUS.

CLVII. CUVIER & VALENCIENNES, *Histoire Naturelle des Poissons*, IX, 1833.

GEORGES CUVIER and ACHILLE VALENCIENNES.

Hynnis Cuvier & Valenciennes, IX, 95; type HYNNIS GOREENSIS Cuv. & Val.

Nauclerus Cuvier & Valenciennes, IX, 247; type NAUCLERUS COMPRESSUS Cuv. & Val.

Young of NAUCRATES.

Porthmeus Cuvier & Valenciennes, IX, 255; type PORTHMEUS ARGENTEUS Cuv. & Val.

Psenes Cuvier & Valenciennes, IX, 259; type PSENES CYANOPHRYS Cuv. & Val.

Lampugus Cuvier & Valenciennes, IX, 317; type SCOMBER PELAGICUS L.
Same as CORYPHÆNA L.

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CLXI. COCCO, *Su Alcuni Pesci dei Mare di Messina:* Giorn. Sci. Lett. Sicilia, XLII, 1833.

Mupus Cocco, 20; type MUPUS IMPERIALIS Cocco (CENTROLOPHUS OVALIS Cuv. & Val.).
Same as LEIRUS Lowe of the same date.

CLXII. COCCO, *Osservationes Peloritani,* XIII, April 1833.

Ruvettus Cocco, 1833, 18; type RUVETTUS PRETIOSUS Cocco.

CLXIII. NARDO, *De Skeponopodo novo piscium genere et de Guebucu Margravii; Species illi cognata:* Mem. Assem. Nat. Vienna, Isis, 1833, fasc. 416.

GIAN DOMENICO NARDO.

Skeponopodus Nardo, 416; type SKEPONOPODUS TYPUS Nardo (XIPHIAS IMPERATOR Bloch & Schneider).

A synonym of TETRAPTURUS.

CLXIV. AGASSIZ, *Poissons Fossiles,* 1833.

LOUIS AGASSIZ.

Catopterus Agassiz, II, 3; type CATOPTERUS ANALIS Agassiz.

A synonym of DIPTERUS.

Amblypterus Agassiz, II, 3, 28; type AMBLYPTERUS LATUS Agassiz.

Notagogus Agassiz, 10; type NOTAGOGUS PENTLANDI Agassiz.

Microps Agassiz, II, 10; type MICROPS FURCATUS Agassiz.

Perhaps not distinct from PHOLIDOPHORUS; name preoccupied in beetles, Meigen, 1823.

Pachycormus Agassiz, II, 11; type ELOPS MACROPTERUS Blainville.

Thrissops Agassiz, II, 12; type THRISSOPS FORMOSUS Agassiz.

Megalurus Agassiz, II, 13; type MEGALURUS LEPIDOTUS Agassiz.

Aspidorhynchus Agassiz, II, 14; type ESOX ACUTIROSTRIS Blainville.

Saurostomus Agassiz, II, 14; type SAUROSTOMUS ESOCINUS Agassiz.

Near to PACHYCORMUS; perhaps not distinguishable.

Gyrodus Agassiz, II, 16; type GYRODUS MACROPHTHALMUS Agassiz (MICRODON ABDOMINALIS Agassiz).

Microdon Agassiz, II, 16; type MICRODON ELEGANS Agassiz.

Name preoccupied by Meigen, 1803, a genus of DIPTERA.

Pycnodus Agassiz, II, 16; type ZEUS PLATESSUS Blainville (CORYPHÆNA APODA Volta).

Cyclopoma Agassiz, IV, 17, 1833; type CYCLOPOMA GIGAS Agassiz.

Calamostoma Agassiz, II, 18; type SYNGNATHUS BREVICULUS Blainville.
Monotypic.

Acanthodes Agassiz, II, 19; type ACANTHOËSSUS BRONNI Agassiz.
A needless substitute for ACANTHOËSSUS.

Smerdis Agassiz, IV, 32, 1833; type PERCA MINUTA Blainville.

RECAPITULATION.

Suggested Changes in Generic Nomenclature of Fishes.

A. Changes resting in Priority.

The following changes from current Nomenclature, apparently justified by the law of priority and the accepted rules, result from the present survey.

Acanthoëssus Agassiz: in place of Acanthodes Agassiz (fossil).
Alabes Cuvier: Cheilobranchus Richardson.
Alosa Linck: Alosa Cuvier.
Anacanthus Ehrenberg: Himantura Müller.
Anchoviella Fowler: Stolephorus Bleeker (not Lacepède).
Apteronotus Lacepède: Sternarchus Bloch & Schneider.
Bagre Cuvier: Felichthys Swainson, Ailurichthys Baird.
Barbatula Linck: Oreias Sauvage, Orthrias Jordan & Fowler.
Bengala Gray (1833): Megarasbora Günther, 1868.
Bodianus Bloch: Harpe Lacepède.
Branchiostegus Rafinesque: Latilus Cuv. & Val.
Caranx Lacepède: Carangus Griffith.
Catonotus Agassiz: Ethestoma Jordan, not Raf.
Cephalopholis Bloch & Schneider: Bodianus Cuv. & Val. (not Bloch). Enneacentrus Gill.
Chelon Röse: Chænomugil Gill.
Citharus Röse: Eucitharus Gill.
Clupanodon Lacepède: Konosirus Jordan & Snyder.
Conger Houttuyn: Conger Cuvier.
Corvina Cuvier: Sciæna Jordan & Evermann (not of Cuvier), Coracinus Pallas.
Curimata Walbaum: Curimatus Cuvier.
Diapterus Ranzani: Gerres Jordan & Evermann (not of Quoy & Gaimard).
Echeneis L.: Leptecheneis Gill.
Echelus Rafinesque: Myrus Cuvier.
Etheostoma Rafinesque: Diplesion Raf.

Eucentrarchus Gill: CENTRARCHUS Jordan & Evermann (not of Cuv. & Val.).
Gaidropsarus Rafinesque: MOTELLA Cuvier.
Gerres Cuvier: XYSTÆMA Jordan & Evermann.
Gnathanodon Bleeker: (CARANX SPECIOSUS).
Hemiulis Swainson (as restricted by Bonaparte, 1839): HALICHŒRES Rüppell, CHŒROJULIS Gill.
Histrio Fischer: PTERYPHRYNE Gill, PTEROPHRYNOIDES Gill.
Hoplias Gill: MACRODON Müller & Troschel.
Hypacanthus Rafinesque: CAMPTOGRAMMA Regan.
Inimicus Jordan & Starks: PELOR Cuv. & Val.
Leucichthys Dybowski: ARGYROSOMUS Agassiz.
Lycodontis McClelland: GYMNOTHORAX Günther (not of Bloch).
Macrodon Schinz: ANCYLODON Cuvier, SAGENICHTHYS Berg.
Macrognathus Lacepède: RHYNCHOBDELLA Bloch & Schneider.
Macrorhynchus Lacepède: DICROTUS Günther.
Membras Bonaparte: KIRTLANDIA Jordan & Evermann.
Merolepis Rafinesque: (SMARIS ZEBRA).
Micrometrus Gibbons: ABEONA Girard.
Mola Kœlreuter: MOLA Cuvier.
Mugiloides Lacepède: PINGUIPES Cuvier.
Narke Kaup: ASTRAPE Gray.
Naso Lacepède: MONOCEROS Bloch & Schneider.
Ompok Lacepède: CALLICHROUS Hamilton.
Ovoides Cuvier: OVOIDES Lacepède.
Pastinachus Rüppell: HYPOLOPHUS Müller & Henle.
Pentanemus Günther: POLYNEMUS Gill (not of L. as restricted).
Peprilus Cuvier: RHOMBUS Lacepède.
Phycis Röse: PHYCIS Bloch & Schneider.
Plagyodus Steller: ALEPISAURUS Lowe.
Pœcilichthys Agassiz: ETHEOSTOMA Jordan & Evermann (not of Rafinesque as restricted).
Polynemus L.: POLYDACTYLUS Lacepède.
Porcus St. Hilaire: BAGRUS Cuv. & Val.
Quinquarius Jordan: PENTACEROS Cuvier.
Remora Forster: REMORA Gill.
Sardina Antipa (S. PILCHARDUS).
Sardinella Val., AMBLYGASTER Bleeker, SARDINIA Poey.
Sciæna L.: ARGYROSOMUS De la Pylaie, PSEUDOSCIÆNA Bleeker.
Scylliorhinus Blainville: CATULUS Smith.

Sphyræna Röse: SPHYRÆNA Bloch & Schneider.
Spicara Rafinesque: SMARIS Cuv.
Stolephorus Lacepède: SPRATELLOIDES Bleeker.
Syngnathus L.: SIPHOSTOMA Raf.
Thrissocles Jordan*: THRYSSA Cuvier.
Thymallus Linck: THYMALLUS Cuvier.
Tor Gray (1833): LABEOBARBUS Bleeker.
Torpedo Houttuyn: TORPEDO Duméril.
Trisopterus Rafinesque: MORUA Risso, BRACHYGADUS Gill.
Typhlinus Rafinesque: TYPHLE Rafinesque, SIPHONOSTOMUS Kaup.
Xystramia † Jordan: GLOSSAMIA Goode & Bean (not of Gill).
Zoramia ‡ Jordan: MIONORUS Jordan & Seale (not of Krefft).

B. Changes resulting from the operations of Opinions 20, 37.

Taking the precedent of Opinion 20, which admits as eligible the generic names of Gronow, and that of 37, admitting those of Brisson, the following changes seem necessary, the status of Klein being almost identical with that of Gronow.

Amia Gronow: instead of APOGON Lacepède.
Amiatus Rafinesque: AMIA L.
Brama Klein: ABRAMIS Cuvier.
Callyodon Gronow: SCARUS Forskål.
Cestracion Klein: SPHYRNA Rafinesque.
Coracinus Gronow: DIPTERODON Cuvier.
Cyclogaster Gronow: LIPARIS Scopoli.
Dasybatus Klein: DASYATIS Rafinesque.
Enchelyopus Gronow: ZOARCES Cuvier.
Glaucus Klein: HYPODIS Rafinesque, CÆSIOMORUS Lacepède.
Hepatus Gronow: TEUTHIS L., ACANTHURUS Forskål.
Labrax Klein: DICENTRARCHUS Gill.
Lepodus Rafinesque: BRAMA Bloch & Schneider.
Leuciscus Klein: LEUCISCUS Cuvier.
Mænas Klein: MÆNA Cuvier.
Mystus Gronow: HYPSELOBAGRUS Günther.
Narcacion Klein: NARCOBATUS Blainville.

* Type CLUPEA SETIROSTRIS Broussonet.
† Type GLOSSAMIA PANDIONIS Goode & Bean: See *Copea*, 1917, p. 46.
‡ Type APOGON GRÆFFEI Günther: See Copea, 1917, p. 46.

Pristis Klein: PRISTIS Linck.
Prochilus Klein: PHOLIS Cuv. & Val. (preoccupied).
Pseudopterus Klein: PTEROIS Cuvier.
Rhina Klein: SQUATINA Duméril.
Rhinobatus Klein: RHINOBATUS Linck.
Rhombus Klein: BOTHUS Rafinesque.
Sargus Klein: DIPLODUS Rafinesque, SARGUS Cuvier.
(new name) CICHLA Bloch & Schneider.
(new name) SOLENOSTOMUS Lacepède.

C. Changes resulting from the operations of Opinion 24, which legalizes the names of Commerson in Lacepède. Those of Plumier in Lacepède are precisely similar.

Alticus Commerson: in place of RUPISCARTES Swainson.
Cheloniger Plumier: CONODON Cuvier.
Chromis Plumier: UMBRINA Cuvier. Unless CROMIS Browne is accepted.
Encrasicholus Commerson: ANCHOVIELLA Fowler.
Pagrus Plumier: NEOMÆNIS Girard.
Sarda Plumier: OCYURUS Gill.
(new name) PAGRUS Cuvier.
(new name) SARDA Cuvier.
(new name) ODAX Cuvier.

D. Hypothetical changes in Nomenclature according to the law of priority but doubtfully eligible, being revised reprints or translations of pre-Linnæan authors; apparently to be rejected under Opinion 57.

Albula Osbeck: SALANX Cuvier.
Apocryptes Osbeck: A valid genus, near BOLEOPHTHALMUS Bloch & Schneider.
Butyrinus Lacepède: ALBULA Gronow.
Cromis Browne: POGONIAS Lacepède.
Heliases Cuvier: CHROMIS Cuvier.
Helops Browne: BODIANUS Bloch.
Menidia Browne: ANCHOVIELLA Fowler, ENCRASICHOLUS Commerson.
Pelmatia Browne: GOBIOMORUS Lacepède, PHILYPNUS Cuvier.
Plagusia Browne: SYMPHURUS Rafinesque.
Rhomboida Browne: VOMER Cuvier.
Saurus Browne: OLIGOPLITES Gill.

E. Changes as under D but the alleged generic names, perhaps to be regarded as Latin vernaculars.

Acus Catesby: PSALISOSTOMUS Klein, LEPISOSTEUS Lacepède.
Alburnus Catesby: MENTICIRRUS Gill.
Bagre Catesby: AMEIURUS Rafinesque.
Harengus Catesby: HARENGULA Cuv. & Val.
Salpa Catesby: NEOMÆNIS Girard.
Saltatrix Catesby: POMATOMUS Lacepède.
Solea Catesby: PLATOPHRYS Swainson.
Suillus Catesby: LACHNOLAIMUS Cuvier.
Unicornis Catesby: OSBECKIA Jordan & Evermann.
(new name) ALBURNUS Rafinesque.
(new name) SOLEA Quensel.

F. Changes in accord with the law of priority, but questionable on account of irregularities not yet passed upon by the Commission of Nomenclature.

Abuhamrur Forskål: PRIACANTHUS Cuvier.
Asper Schæfer: ASPRO Cuvier.
Asperulus Schæfer: ZINGEL Oken.
Cernua Schæfer: ACERINA Güldenstadt, GYMNOCEPHALUS Bloch.
Daba Forskål: EPINEPHELUS Bloch.
Djabub Forskål: THERAPON Cuvier.
Galeus Valmont: PRIONACE Cantor.
Gaterin Forskål: PLECTORHYNCHUS Lacepède.
Ghanan Forskål: SCOLOPSIS Cuvier.
Hobar Forskål: LUTIANUS Bloch.
Louti Forskål: VARIOLA Swainson.
Mustelus Valmont: CYNIAS Gill.
Pleuracromylon Gill: MUSTELUS Leach.
Quinquarius Jordan: PENTACEROS Cuvier.
Ramphistoma Rafinesque: BELONE Cuvier.
Schour Forskål: LETHRINUS Cuvier.
Schraitzer Schæfer: LEPTOPERCA Gill.
Tahmel Forskål: KYPHOSUS Lacepède.
Vulpecula Valmont: ALOPIAS Rafinesque.

G. Changes due to virtual preoccupation of names now in use.

If we follow the current practice of regarding generic names in words otherwise similar and from identical roots, the same word if differing

only in gender, in the presence or absence of the initial *h* in words of Greek origin, or by the use of *i* or *o* as a connective, the following changes are necessary in the current nomenclature, as given by Jordan & Evermann, *Fishes N. M. America*, 1898.

Cenisophius Bonaparte: in place of LEUCOS Heckel, on account of the earlier LEUCUS.
Centridermichthys Richardson: TRACHIDERMUS Heckel; TRACHYDERMA.
Cheilonemus * Baird: LEUCOSOMUS Heckel; LEUCOSOMA.
Cremnobates Günther: AUCHENIPTERUS Günther; AUCHENOPTERUS.
Cynicoglossus Bonaparte: MICROSTOMUS Gottsche; MICROSTOMA.
Eudulus Fowler: DULES Cuvier; DULUS.
Evermannellus Fowler: ODONTOSTOMUS Cocco; ODONTOSTOMA.
Haloporphyrus Günther: LEPIDION Swainson; LEPIDIA.
Hemiulis Swainson (as restricted by Bonaparte, 1839); HALICHŒRES Rüppell; HALICHŒRUS.
Hypolophus Müller: PASTINACHUS Rüppell; PASTINACA.
Nebrodes Garman: NEBRIUS Rüppell; NEBRIA.
Notoscopelus Günther: MACROSTOMA Risso; MACROSTOMUS.
Pisciregia Abbott: GASTROPTERUS Cope; GASTROPTERON.
Podateles Boulenger: ATELEOPUS Schlegel; ATELOPUS.
Quassilabia Jordan & Brayton: LAGOCHILA J. & B.; LAGOCHEILUS.
Scaphirhynchops Gill: SCAPHIRHYNCHUS Heckel; SCAPHORHYNCHUS.
Scytaliscus Jordan & Gilbert: SCYTALINUS J. & G.; SCYTALINA.
Stenesthes † Jordan: new name for STENOTOMUS Gill; STENOTOMA.
Thrissocles Jordan: new name for THRYSSA Cuvier; THRISSA.
Xiphister Jordan & Gilbert: XIPHIDION Girard; XIPHIDIUM.

H. Questionable cases, similar to G.

Catochænum Cantor: GERRES Cuvier, on account of the prior GERRIS.
Centracion Gray: HETERODONTUS Blainville; HETERODON.
Choregon Minding: THYMALLUS Cuvier; THYMALUS.
Corythobatus Cantor: MINOUS Cuv. & Val.; MINOIS.
(new name) CHLOËA Jordan & Snyder; CHLOËIA.
(new name) GRAMMA Poey; GRAMMIA.
(new name) NEBRIS Cuvier; NEBRIA; NEBRIUS.

* Type CYPRINUS CORPORALIS Mitchill, CYPRINUS BULLARIS Rafinesque.
† Type SPARUS CHRYSOPS L.

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In the following list, the names of genera apparently valid are left unmarked; *d* indicates doubt of one form or another; *s* indicates synonyms, apparently never to be revived or added to the system.

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